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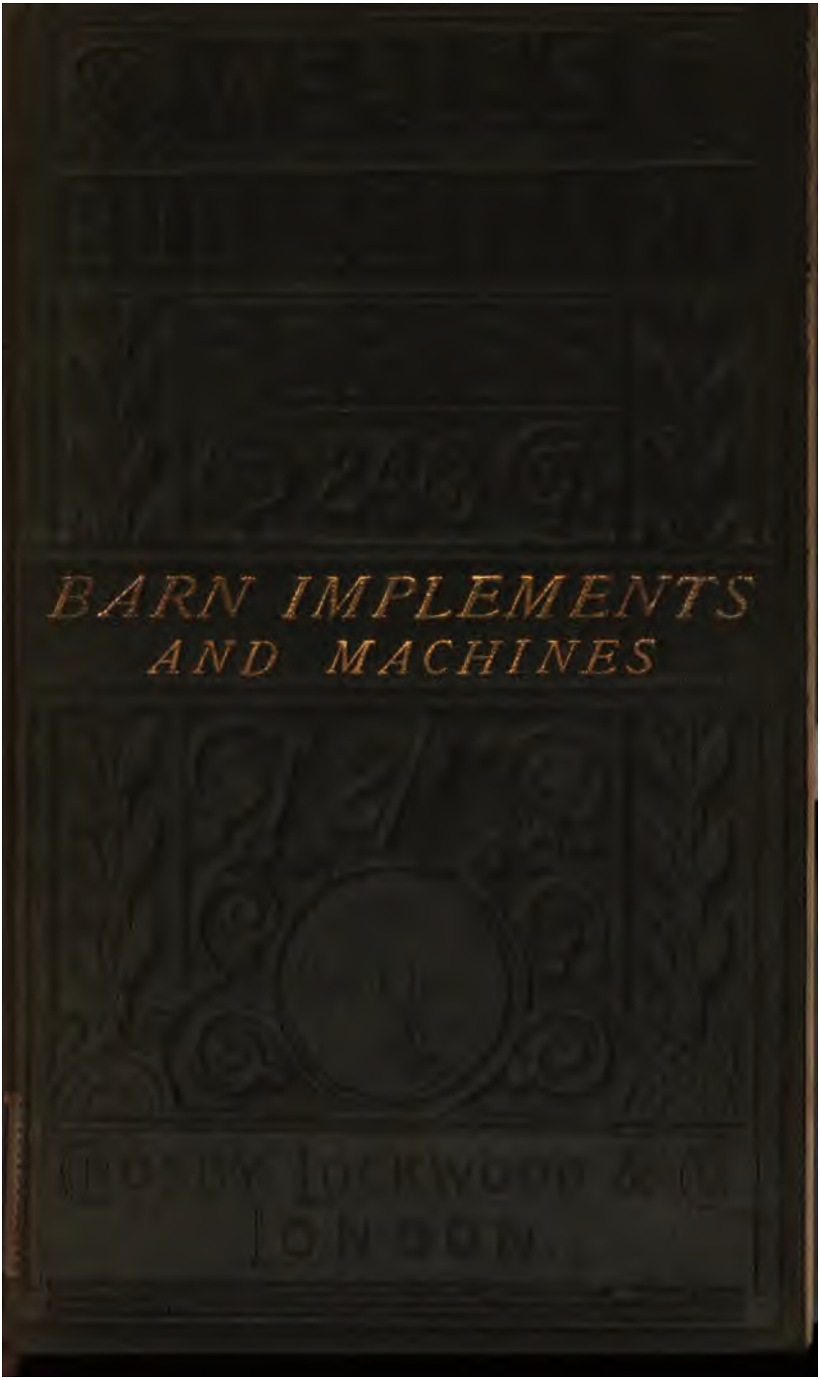

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A

PRACTICAL TREATISE

ON

THE APPLICATION OF POWER TO THE OPERATIONS
OF AGRICULTURE; AND ON VARIOUS MACHINES
USED IN THE THRESHING-BARN, IN THE
STOCK-YARD, AND IN THE DAIRY,
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PREFACE.

THIS volume will, we hope, give the agricultural student and the young farmer some idea of the giant strides which have latterly been made in agricultural mechanics, and which are still going on. The progress in this respect has been of a three-fold character. New machines have been invented and old ones greatly improved; new motive powers have been utilised to work them; and new methods of transmitting power and of arranging barn machinery have of necessity followed.

It has been deemed proper to devote a considerable section of the present book to an elucidation of the motor powers now in use, or likely to come into use, on the farm. The principle of the steam-engine has naturally been expounded at some length. Gas-engines, hot-air engines, turbines, and other water motors, have also been described as fully as space would permit. And in anticipation of the time, not very distant, we imagine, when the ploughman will be seen riding on his plough with one or more days' store of electric energy under the seat, and the implement he steers turning over the soil with a speed, ease, and economy that immeasurably distances even the best performances of the steam-plough, electricity as a motor power, has received some share of attention.

Fixed barn works are now a thing of the past. The ponderous fixtures found in many barns erected within the last quarter of a century are now judged unnecessary, both on account of their expense and because they absorb too much power for the amount of work they perform.

In working barn machinery, horses are superseded to a great extent by the steam-engine, or, where that is found too expensive, a hot-air engine, a gas-engine, or a water motor is now commonly employed. In such cases the method of transmitting power is usually through belting or by means of a driving-shaft, instead of toothed wheels. If horse-gear is used, none of the old expensive horse-wheels are erected, a portable description having taken their place.

Since the days of "Old Mortality," and the introduction of the winnowing-machine, when the use of that artificial aid to separating the chaff was regarded as a direct thwarting of the will of Providence, the farm-yard has been invaded by a host of inventions, some of them far more wonderful in their way than the "new-fangled" machine which created such consternation in the minds of the good people of Tillietudlem.

In the barn itself, the winnowing-machine has been fairly eclipsed by the modern threshing-machine; and under the same roof, without an exception almost, we meet with the still more recent machines, the chaff-cutter, the root-pulper, the cake-crusher, and corn-bruiser. In the rick-yard, we find machines for artificially drying hay and corn, for stacking hay and straw, and for trussing, baling, and compressing fodder of all kinds. In the dairy, again, there are machines which artificially separate the cream from the milk, and a great variety of others all tending to improved methods of dairying. And in the poultry-yard, amongst the marvels of the age, we may number the artificial mothers or incubators and the cramming-machine.

These are only a few of the more recent barn implements and machines.

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BARN IMPLEMENTS AND MACHINES.

CHAPTER I.

MOTIVE POWERS.

THE sources of energy may be summarised as tides, food, fuel, wind, rain, and solar heat.

Tides are a practical source of energy, because of the existence of tide-mills; but it is a source which can only be rare in its use as compared with other motors. It is difficult in the case of docks to economise tidal energy by artificial dock basins, but there are places in the world where it would be possible, and even advantageous, to build a sea-wall across the mouth of a natural basin or estuary, and utilise the tidal energy, filling and emptying it by means of sluices and water-wheels. If this, however, can be done, but little more would be needed to keep out the water altogether, and make fertile land of the whole basin. It thus becomes an interesting economic question: "Which is most valuable, 40 acres of land, or the 100 horse-power which would be produced by 40 acres of water obtained in the way referred to?" In one case the answer would be the horse-power, in another the acres; but the question is hardly worth answering, considering the rarity of the cases where embankments for the utilisation of tidal energy are practicable Much information as to sea-power and tidal-mills will be found in Sir R. Cane's valuable work, the "Industrial Resources of Ireland."

Food is productive of *manual* and *horse-power*; just as *fuel* is the instrument which gives power to the *Steam-Engine*, the *Gas-Engine*, and the *Hot-air Engine*. Each of these will be found treated of in a different part of this work.

Wind-power has more or less fallen into disuse, but this decadence may not be permanent. The coal-pits are becoming exhausted, slowly though surely, and the price of coal tends upwards. Long before coal is exhausted, therefore, wind may be again brought into greater requisition both on land and at sea. Even now it is not utterly chimerical to think of wind superseding coal in some places for various purposes. But until new inventions are made it does not seem probable that wind can be economically used in any considerable class of cases, or to put energy into store for work of other kinds. In another volume of this series ("Irrigation and Water Supply") the value of wind-power for pumping water for the supply of the homestead, and for watering and irrigating fields and gardens, has been referred to; and illustrations and descriptions of the most effective wind-mills at present available for such purposes are also given.

Rain-power has been chiefly utilised on the farm in the shape of collected drainage-water to drive threshing and other machines; but the splendid suggestion of Sir W. Siemens that the power of Niagara might be utilised by transmitting it electrically to great distances, has given quite a fresh departure in respect of economy to rain-power. The difficulty of economising the electrical transmitting power to great distances may now be accounted as overcome, and it is impossible to foresee what may not be the effect in the future.

Sun-heat may also possibly be utilised with good effect as a motor-power—at least in tropical regions—long before our coal-fields are exhausted. M. Mouchot's solar engine is an example of what may be done in this direction. It is stated that an improvement of Mouchot's engine, devised by M. Pifre, has gone so far as to utilise 80 per cent. of the available heat of the sun's rays at Paris; and the latter has actually constructed an apparatus with which he pumped water to a height of 10 ft. at the rate of over 20 gallons a minute. As in Mouchot's solar engine, a reflector receives the light and concentrates it upon a boiler, in this case containing nearly 90 gallons of water, which, under a clear Paris sky, begins to boil in about 40 minutes, and in a few minutes longer has sufficient pressure to drive the engine working the pump. In the not distant future, then, tropical countries will be the place where motive power can be had for next to nothing.

CHAPTER II.

WATER-POWER.

OF all motive power the one obtained from a fall of water is the best suited and cheapest for the agriculturist, and if it can possibly be obtained, is well worth considerable trouble and first outlay.

Water-Wheels.—Hitherto, in the farm at least, the motive power of water has been chiefly applied to drive machinery by means of the old water-wheel, which is of three kinds—the *overshot*, the *breast*, and the *undershot* wheel.

The overshot wheel is the most powerful of these, as in this case the whole fall of the water being something greater than the diameter of the wheel, is employed in producing the power, which in some cases, where the machinery is of superior description, is as much as 75 per cent. of the actual fall of water.

The water is supplied to the wheel from a trough or shoot, the bottom surface of which should be about 0·4 of a foot from the crown of the wheel to allow of the water obtaining a little greater velocity than the outer edge of the wheel. On some wheels the water is admitted a little below the crown, in which case the wheel is made of a greater diameter than the depth of the fall. The width of the trough should be something less than the width of the wheel, to prevent waste, and allow for the escape of the air from out of the buckets.

The overshot is best adapted for small streams of considerable fall; and the breast-wheel for large streams with a small fall; while the undershot is chiefly used as a flood wheel, or for obtaining motive power from the ebb and flow of the tide.

These wheels, however, being both cumbersome and costly, are being rapidly superseded by the cheaper, more efficient, and more convenient Turbine and Water-Engine.

The Turbine.—The turbine is an improved machine for applying water-power, and is adapted for working all descriptions of machinery. It is equally suited for low and high falls, and possesses great advantages over the ordinary vertical wheel. In first cost it is almost invariably much cheaper; it is erected at less expense, a small bed of masonry only being required as a foundation, whilst it yields the highest obtainable percentage of power from a given quantity of water. The speed needed for driving machinery is also obtained direct from the wheel-shaft, without the heavy intermediate gearing required with the ordinary wheel, as the turbine makes, on falls of average height, from 200 to 500 revolutions in a minute.

Turbines have long been extensively employed on the continent, and more recently in the United States of America, and have been constructed in a great variety of forms, some of them being so designed as to attain a high efficiency, whilst others are altogether unsuited for use where economy in the consumption of water is desired. When properly constructed, however, the turbine cannot be excelled as a means of applying water-power, and it possesses many important advantages over the ordinary water-wheel.

Among the most obvious of these advantages the following may be enumerated:—

1st. It is usually much cheaper in cost, especially for high falls.

2nd. It is erected at less expense, a small bed of masonry only being required as a foundation.

3rd. It yields the highest obtainable power from a given quantity of water, and is equally efficient for high and low falls. On low falls it greatly exceeds the ordinary breast and undershot wheels in economising the water.

4. Its action is not impeded by back-water, consequently it may be placed at or below the level of the water in the tail-race. The entire fall is thus rendered available at all times, whilst the ordinary wheels (for low falls especially) in order to be out of back-water in floods, often require to be placed so high as, in dry weather, to cause an important part of the fall to be wasted in the tail-race.

5th. The number of revolutions it makes per minute is such that the speed required for driving machinery can usually be obtained direct, or with a single pair of small wheels in lieu of the heavy intermediate gearing needed with the ordinary water-wheel.

6th. From its small size it can be employed in many situations where the cumbrous vertical wheel is not available.

Amongst the turbines generally used on the continent, and which have been introduced to some extent in this country, those invented by Fourneyron (in which the water is admitted to the central part of the wheel and passes out of the circumference) and by

Jonval or Fontaine (where the flow is in a direction parallel with the axis), are the best in principle, and have attained the highest efficiency.

The Vortex Turbine or Water-Wheel.—The "Vortex" is an improved form of turbine, the invention of Professor James Thomson, and has been manufactured for many years by Williamson Brothers, who are now sole licensed makers. During this time it has been brought into most extensive use for a great variety of purposes in all parts of this country and abroad. It has been applied on falls ranging from 3 ft. to 400 ft. Its superiority as a means of applying water-power has been generally recognised by those who have had experience of its working.

The Vortex consists of a movable wheel with radiating vanes, which revolves upon a pivot, and is surrounded by an annular case, closed externally, but having towards its internal circumference four curved guide passages. The water is admitted by one or more pipes to this case, and issuing through the guide passages, acts against the vanes of the wheel, which is thus driven round at a velocity proportionate to the height of fall. The water having expended its force, passes out at the centre, and below the case.

The advantages of the Vortex wheel or inward flow turbine over other forms of turbine have been stated by the late Professor Rankine to be due to the following four circumstances :—

I.—Its discharging water near the centre of the wheel.

II.—The action of centrifugal force in regulating the pressure of the water within the wheel.

III.—The mode of varying the supply of water when required.

IV.—The action of centrifugal force in regulating the speed.

I.—The advantage of discharging the water near the centre of the wheel is of the following kind: In every form of turbine a whirling motion is given to the particles of water before they begin to drive the wheel, and the efficiency of the turbine depends on the completeness with which that whirling motion is taken away from those particles during the action on the wheel. By discharging the water from a part of the wheel whose motion is comparatively slow, the practical fulfilment of that condition is rendered more easy and certain.

II.—The action of centrifugal force in the regulation of the pressure within the wheel is of the following kind: It is favourable to economy of power that the effective pressure of the water immediately after entering the wheel should bear a certain definite proportion to the effective pressure in the supply-chamber not differing much in any case from one-half. The centrifugal force of the water which whirls along with the vortex wheel tends to preserve at its circumference the very pressure which is most favourable to economy of power; and the centrifugal force of the two discs of water contained between the wheel and the two shields or covers of the wheel-chamber prevents that pressure from making the water leak out between the wheel and the casing.

III.—The action of centrifugal speed is as follows: Should the load be suddenly diminished and the wheel begin to revolve too fast, the centrifugal force of the water whirling along with it increases and opposes the entrance of water from the supply chamber; on the other hand, should the load be suddenly increased and the wheel begin to revolve too slowly, the centrifugal force of the water whirling along with it diminishes and allows more water to enter from the supply-chamber; and thus sudden variations of the load are prevented from causing excessive fluctuations of speed —the whirling water acting as a governor. In outward-flow turbines, the centrifugal force of the water acts in a contrary way and tends to increase the fluctuation of speed. In parallel-flow turbines it has no sensible action of either kind.

IV.—The advantage of the mode of varying the supply of water to the vortex wheel by means of movable guide-blades turning about their inner ends, is of special importance, and consists in this, that how small soever the supply of water may be made the passages through which it flows are always of a smooth and continuous form, and free from enlargements and from sudden contractions or throttlings; which causes of waste of power can never be wholly avoided when the supply is regulated by sluices or slide valves.

The construction of the vortex and the mode in which the water is applied in it, will be readily understood by reference to Figs. 1 and 2.

The vortex represented in Fig. 1 is shown with the cover removed. Fig. 2 shows the case complete, as it is usually placed at the bottom of the fall. A is the revolving wheel keyed on the shaft C, B one of the guide-blades, D the bell-cranks and shafts connecting the guide-blades with the outside bell-cranks and coupling-rods E, F guide-blades gear, G bracket and screw for raising the pivot (the pivot cannot be seen in the sketch), H wheel-cover, and I supply-pipe by which the water enters the case.

In Fig. 3 the vortex is shown in position, arranged vertically, with part of the fall acting by suction. It

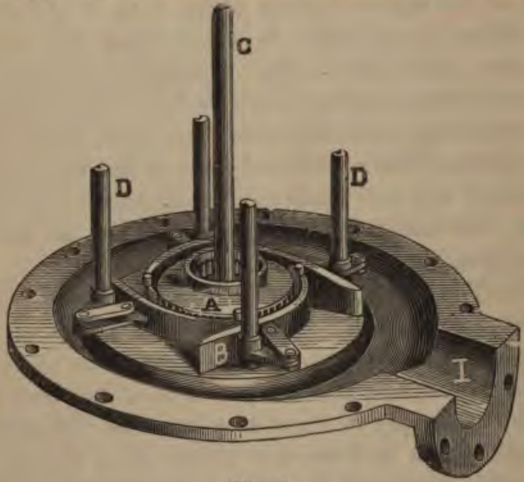


Fig. 1.

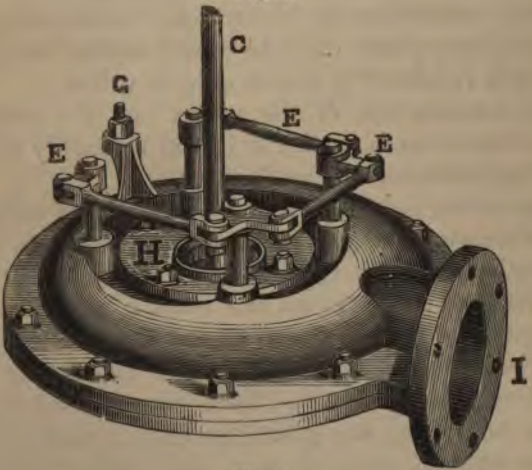


Fig. 2.

may be thus placed at any height not exceeding 30 ft.

above the tail water. The water after it leaves the vortex passes by two pipes into the tail-race, and by "suction" in these pipes the fall below the wheel is utilised. The vortex stands upon two beams placed across the pit or well leading to the tail-race. The shaft is horizontal, and passes through stuffing-boxes in the bend of the suction-pipes. The power is taken from the pulley, which is shown upon the shaft.

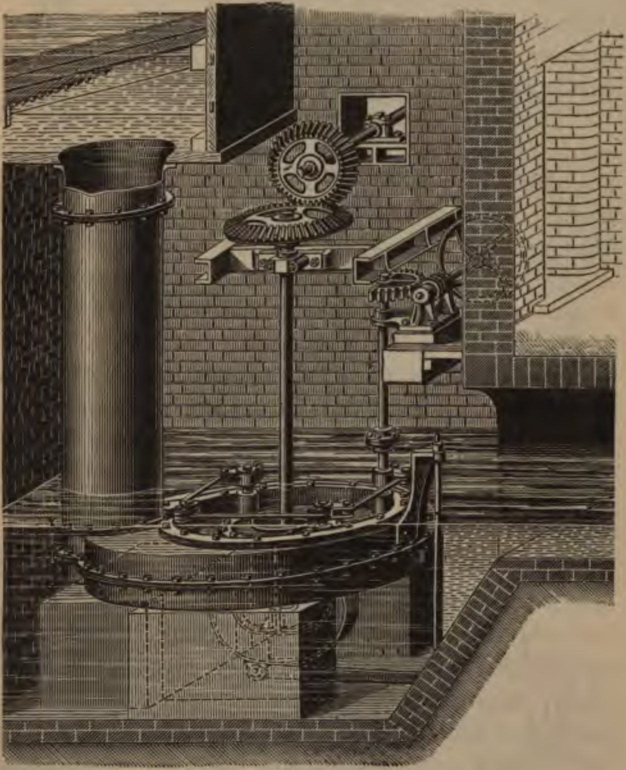


Fig. 3.

In the engraving a portion of the pen-trough is represented as broken away, so that the cast-iron strainer plates, which are used to prevent the entrance of stones, sticks, &c., into the turbine, may be seen.

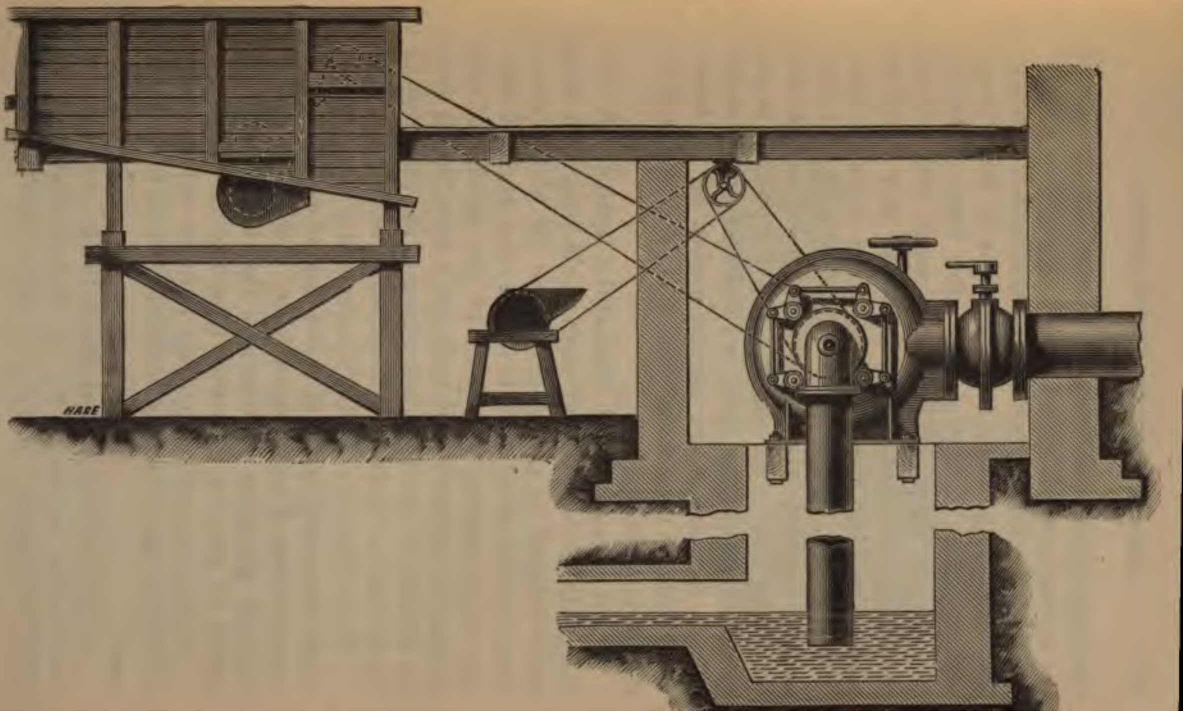
Messrs. Williamson Brothers have erected one ot these vortex turbines at the Homescale Farm, Old Hutton, near Kendal, for W. E. Maude, Esq., who writes as follows :—

"The turbine-wheel you have made and erected for me is in constant use, and fully answers the purpose for which it was intended. I may also add that the shafting and all the agricultural implements, threshing machine, winnowing-machine, straw-cutter, cake-crusher, and turnip-pulper, which you have attached to the turbine-wheel, work satisfactorily all together. A circular saw is being attached.

"The wheel, which is 10 ins. in diameter, and driven by a 30 ft. column of water, confined in a 9-in. pipe, is, in the opinion of Mr. Knowles, who manages the farm, equal to the united force of eight farm horses. The threshing-machine alone required four good horses last year.

"Wherever a small stream of water or reservoir, coupled with 20 to 30 ft. fall, can be obtained, I think turbines may be applied with great advantage for agricultural purposes, being very simple and always ready, whereas steam-engines require an attendant possessing some mechanical knowledge, coal, and probably more repairs than the beautiful adaptation of water-power in question."

Fig. 4 represents a 5-horse power turbine with a fall of 16 feet, with adjustable blades. It is working a 4-horse power threshing-machine direct from the pulley on the turbine-spindle. The turbine-spindle is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running at 300 revolutions, and the drum-spindle of the threshing-machine at 1,000 revolutions, per minute. There is no loss of power by intermediate gearing. The drum of the threshing-machine is 36 inches long, and the grain is once dressed after being threshed. The turbine supplies a surplus of water, and, without increasing it, elevators or corn creeps may safely be added; as, when the guide-blades are opened to their fullest extent, the turbine will yield 6½-horse power. In dry weather, when very little water can be obtained, by closing the guide-blades it is possible to use to advantage all that there is; and root pulper, chaff-cutters, &c., may at any time be worked off the barn-shaft without more water than is actually required to do the work being used.

If our engraving had illustrated a turbine with 150 feet fall, the turbine and pipes would have been very much reduced in size, as only about $\frac{1}{10}$ of the water would have been required to do the same work. Under any circumstances, the speed of the spindle of the turbine for ordinary farm purposes is such, that it may be connected direct by belt either to the line-shaft in the barn or to the drum-shaft on the threshing-machine.

Water-Engines.—Bailey's water-motor is one of the most economical types of water-engine ever invented, as every drop of water exerts force. Actual experience at high pressures demonstrates that it is possible to obtain 86 per cent. duty with these motors.

The water-pressure engines have no valves, cocks, springs, or other delicate machinery liable to derangement.

Bailey's water-motor, as shown in the engraving, is used in the stables of Sir H. Hussey Vivian, Bart., M.P., at Swansea; and also in Major Best's stables at

Llangollen, for chaff-cutting, oat-bruising, pumping water, and other purposes.

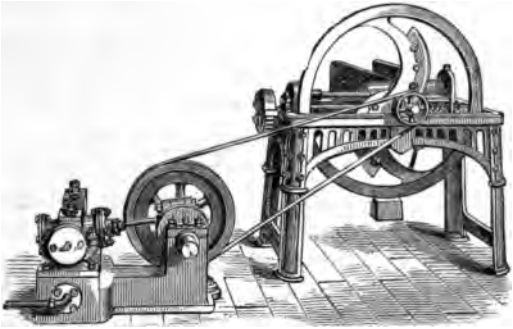


Fig. 5.

Prices for pressures from 20 lbs to 90 lbs. on the square inch.

Size.	Bore of Cylinder.	Revolutions per Minute.	Diameter of Pipes.			Feet.	98	131	164	196	† Air Vessels extra.		
						Lbs.	*45	60	75	90			
							Approximate Horse Power with the above pressures.						
No.				£	s.	d.					£	s.	d.
2	1¾	220	1	10	0	0	¼	⅓	⅖	½		5	0
1A	2¼	200	1½	12	10	0	½	⅔	⅚	1		6	6
3A	3⅛	160	2¼	15	0	0	1	1⅓	1¾	2		7	6
4	4	140	2½	25	0	0	1¾	2¼	3	3½		12	6
5	4¾	120	3	35	0	0	2½	3½	4½	5¼		17	6
6	5½	100	4	50	0	0	3	4	5	6	1	5	0
7	6⅝	90	4½	65	0	0	4½	6	7½	9	1	12	6
8	7	85	4¾	80	0	0	6¼	8½	10½	12½	2	0	0
9	9⅞	80	5¼	95	0	0	8	10½	13½	16	2	7	6
10	8⅝	75	5¼	120	0	0	9¾	13	16¼	19½	3	0	0
11	9½	70	6	:140	0	0	12	15¾	19½	23½	3	10	0
12	10¼	65	6	180	0	0	14½	19¼	24	29	4	10	0

These motors, if specially ordered, will do for either steam or water.

* It will be obvious that at half 45 lbs. pressure, that half the power will be developed, in other words, the lower the pressure is, the larger will be the motor required.

† An air vessel on the inlet prevents vibration and increases the power.

CHAPTER III.

THE STEAM-ENGINE.

The mechanical action of steam is usually accomplished by a piston moving in a cylinder. The cylinder is a tube in most cases of greater length than the proportion of its diameter.

The piston is a plug fitted accurately to the bore of the cylinder, not so tightly as to prevent its being easily slid from one end of the cylinder to the other, yet sufficiently so as to prevent the passage of steam between it and the side of the cylinder.

Attached to the piston on one side in its centre is a circular rod accurately turned from end to end, called the piston-rod.

Each end of the cylinder is closed by lids, through one of which the piston-rod passes; this is kept perfectly steam-tight by a packing of hemp soaked in oil and tallow.

A blast of steam being admitted on one side, the piston is forced onwards to the other end, and a similar blast being admitted on that side (and the means of escape being opened on the other), the piston is then pushed back to its former position; thus the primary power produced by steam-power is an alternate motion backwards and forwards in a straight line; but by an infinite number of well-known mechanical contrivances, this alternate motion may be made to produce any other kind of motion that may be desired; thus, we may make it keep a wheel in constant rotation, or move a weight continually in the same straight line, and in the same direction. The various details by which these objects are effected, and which constitute the working parts of the engine, we will now proceed to describe separately.

First, the means by which steam is admitted into and allowed to escape from the cylinder. This requires two apertures to be made at each end of the cylinder, one for the admission, and the other for the escape, of the steam; the first must have a communication with the boiler, and the latter with the vessel where the steam is condensed, as in condensing engines, or into the atmosphere, where it escapes, as in high-pressure engines.

These apertures, or steam-ports, must of necessity require to be alternately opened or shut, which is done by contrivances called puppet-valves—those which open a communication with the boiler being called steam-valves, and those which open the communication with the condenser are called exhaust-valves.

These valves are conical discs, fitting lightly into holes, from which they are lifted or drawn, and to which they return alternately: they are made of gun-metal, with their faces ground so as to fit with the greatest precision.

In lieu of these valves an arrangement is often made for effecting the same end by what are called slides. The two openings to the cylinder in this case being ground to a flat surface, upon these two plates or discs, also ground to a true surface, pass backwards and forwards, thus covering or uncovering by pairs the openings for the admission or escape of the steam.

The manner in which these valves act is thus: Supposing the cylinder to be placed in a vertical position (which it is not always), when the piston arrives at the top of the cylinder, two valves, the upper steam-valve and the lower exhaust-valve, are required to be opened, and at the same moment the two other valves, the lower steam-valve and upper exhaust-valve, must be closed. Now, as all these movements are simultaneous, it may be easily imagined that the four valves may be so connected that a single movement imparted to them should open one pair and close the other.

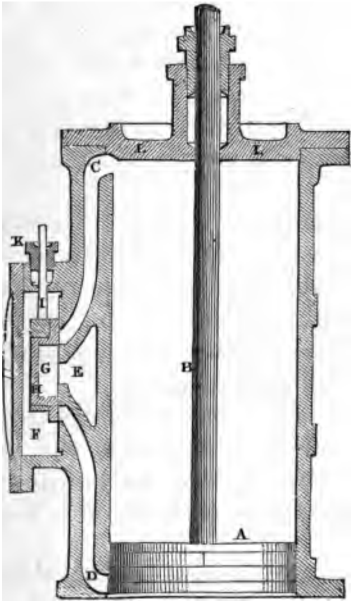


Fig. 6.

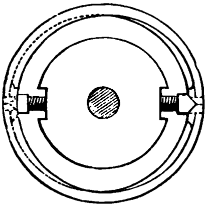


Fig. 7.

When the piston arrives at the bottom of the cylinder, a single motion in the contrary direction will evidently effect the object to be attained, that is to say, to open the lower steam-valve and upper exhaust-valve, and close the upper steam-valve and lower exhaust-valve. This will be better understood by reference to Figs. 6 and 7.

To render the engine self-acting, some contrivance must be adopted by which these valves will be regularly opened or shut by the action of some part of the engine itself.

The means generally adopted for opening and shutting valves and working slides is by what is called an eccentric, as seen in Fig. 8.

This consists of a circular plate of metal, *a a*, fixed upon a shaft, *e*, at some distance from its geometrical centre. Round this eccentric point it is made to revolve, and in revolving it is evident that its geometrical centre revolving round its centre of motion will be thrown alternately to the right and left of such centre.

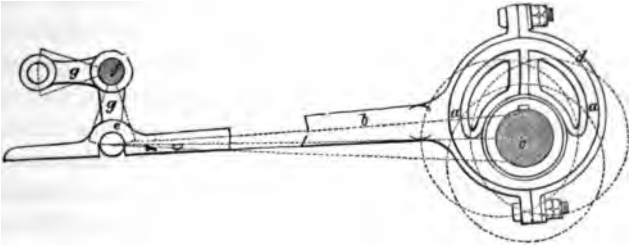


Fig. 8.

Round this circular disc is placed a ring, *d*, within which it is at liberty to turn, but not to turn the ring with it; the ring will consequently be thrown alternately to the left and right of the centre on which the eccentric plate is made to turn, and the throw or length of its play right and left will be equal to twice the distance of the geometrical centre of the disc to the centre on which it actually turns. To this ring is attached a bar, *b*.

As the centre is thrown alternately right and left of *e* by the revolution of the disc, the point *e* receives a horizontal motion, right and left, to a like extent. The motion is transmitted by means of the levers, *g g*, to the slides of the cylinder by the mechanical arrangement shown in the cut.

With whatever force the piston be impelled, the effects of that force will be augmented just in proportion to the amount of vacuum produced in that part of the cylinder towards which the piston is pressing. Now, if one cubic foot of steam be reconverted into cold water, it will be reduced to one cubic inch of liquid, and we shall get the entire cubic foot (minus one inch) of vacuum, and therefore for every cubic foot of steam in the cylinder, we shall have a cubic foot of vacuum, minus one cubic inch. It is this advantage that is sought to be obtained by using what are called condensing engines, and it is to the genius of Watt that the great difficulty of condensing the steam without cooling the cylinder has been overcome; for previous to his time (1763), the steam was condensed in the steam cylinder, which was consequently cooled down at every stroke of the engine. Watt's invention consisted in the producing an almost perfect vacuum without in the slightest degree lowering the temperature of the steam cylinder, and this he effected by placing near the cylinder another vessel submerged in cold water, and having a jet of cold water constantly playing within it. Whenever he desired to condense the steam in the cylinder, he opened the communication by a valve between this vessel and the cylinder, and immediately the steam, by its elastic force, rushed into this vessel and was instantly condensed, leaving in the cylinder an almost perfect vacuum, and at the same time exposing the cylinder to no cold which could in the slightest degree lower its temperature.

Now, the second vessel, or condenser, would in time become filled with water from the jet, and condensed steam, as well as air, which would enter in a fixed form in the water, and which would be liberated by the warmth of the steam condensed by the water. This air would, to a considerable extent, vitiate the vacuum in the condenser. These impediments were surmounted by the adjunct of a pump to the condenser, by which the water supplied by the jet and the condensed steam, as well as air, were constantly pumped out by an apparatus called the air-pump.

To prevent the water surrounding the condenser from becoming warm, there is placed a pump and waste-pipe—the pump for supplying cold water, which, by its superior gravity, sinks to the bottom of the cistern, and the waste-pipe to carry off the warm water, which, being lighter, rises to the top.

Having, by the means which we have described, produced a continual self-acting reciprocating action of the piston, the next thing is to apply that motion to the machinery required to be moved, and this is done by attaching it at once to a beam, called the working beam: this is supported on a fixed axis, and alternately vibrates upwards and downwards as it is moved by the action of the piston through the piston-rod.

Now, it is evident that the ends of the beam to which the piston would be attached could not move upwards and downwards in a straight line (as the piston-rod does), but must describe the arc of a circle, whose centre would be the axis upon which the beam vibrates.

The piston-rod, as we have before described, is an accurately turned bar of iron, working through the centre of the cylinder-cover, and kept securely in that position by the packing in the stuffing-box, and unable to swerve to the right or to the left; consequently, if the head of the piston-rod was fastened to the end of the beam, it would be strained and bent by the motion of the beam. To remedy this inconvenience, it is necessary to place between the end of the beam and the top of the piston-rod a piece of mechanism called the parallel motion, which accommodates the curvilinear motion of the one to the rectilinear motion of the other. This is formed in a variety of ways; but the most common is the arrangement invented and used by Mr. Watt, and is considered one of his brightest thoughts. It is a continuation of rods, so arranged and joined together that while one of their pivots is moved alternately in a circular arc, like the end of the beam, some point upon them will be moved alternately upwards and downwards in a straight line. This will be readily understood by reference to the plate.

As nearly all motions that are required for driving the machinery of mills are effected by the constant turning of a wheel upon a shaft, it is necessary now to convert this reciprocating motion in a straight line, to which we have now arrived, into, as nearly as possible, a continually acting rotatory one, and this is generally effected by another invention of Watt's, called a crank. This is an application of the ancient method of giving motion to the potter's lathe, the original inventor of which is unknown, and even the era of its introduction.

The crank is an arm attached generally to the centre of the wheel, which it turns in the same manner as the motion is imparted to a winch or windlass—a thing of such common application, that it can require no description here. As a matter of convenience, in those engines worked with a beam, there is interposed between the end of the beam and the crank a strongly formed bar of iron called the connecting-rod.

Having by the means we have briefly described now got a self-acting machine ready to apply to any purpose required, there remains only one other point necessary to be attended to—and that is of considerable importance—being the means by which the power we have got may be kept within bounds, when inclined to exert itself too much, or stimulated when inclined to flag; and it would be continually falling into the one error or the other, however well the machinery might be constructed, as the work it was employed to do might increase or decrease in load upon it. To remedy this defect, Mr. Watt adopted an ingenious contrivance which is now called the governor, shown in Fig. 9.

A similar irregularity to the one we have described, occurred in the motion of corn-mills, from the varying quantity of water or resistance. It had early exercised the ingenuity of millwrights to obtain some means by which its injurious effects could be obviated, and the means they adopted was attaching a couple of heavy balls to a jointed rod. These balls were made to revolve by being connected with the spindle or axis of the mill-runner, and the apparatus was called a lift-tenter. The centrifugal force of these balls when in motion either raised or lowered a stage in which the arbor of the spindle revolved, and brought the stones nearer, or removed them farther from, each other, as they might require to be adjusted. This most ingenious regulator Mr. Watt applied to regulate the opening and shutting of the throttle-valve of the steam-engine. Fig. 9 shows the manner in which this is effected. I I are two balls attached to two rods [illegible]. When the balls separate so that the rods [illegible] become more divergent, the arms H F open, and the points [illegible], separating, draw down the collar E, which slides on the spindle. When the balls, instead of diverging, approach each other, the arms H F also approach each other, and the collar E is lifted. Thus, as the balls, by the action of centrifugal force, diverge or contract towards the seat they occupy when

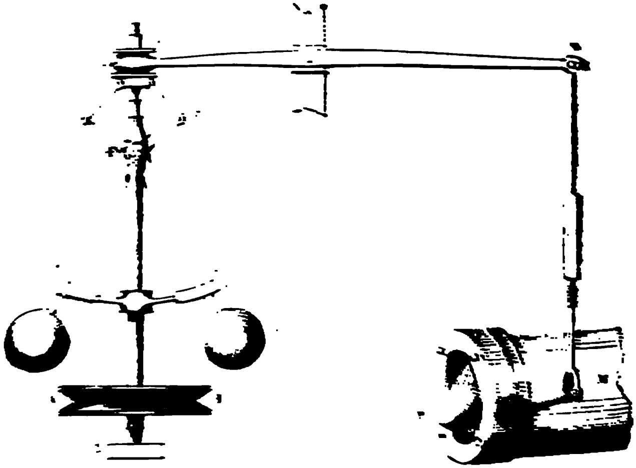


Fig. 1.

the engine is at rest, the collar E is raised or lowered by means of a lever, [illegible], having a fork formed at one end, which receives the motion of the sliding collar E, and transmits it to the lever of the throttle-valve, as shown in the cut. A rotatory motion is given to the balls by a strap, gut-line, or gearing to the pulley A B (fixed upon the lower part of the spindle) from any convenient part of the machinery in motion.

As it is necessary that the boiler be supplied with water equal to that evaporated and consumed by the engine in the shape of steam, it is usual to employ the power of the engine to work pumps for that purpose. In condensing engines water is supplied to the boiler from the condenser, extracted by the action of the air-pump, as this water is considerably warmer than that drawn direct from the original source, and is of course a saving of so much heat.

As this supply of water requires to be merely regulated, a self-acting apparatus is attached to the boiler, but this arrangement is only applicable to low-pressure boilers, as the column of water or head would require to be inconveniently high to overcome the great pressure of the steam in the latter case. Therefore forcing or feed-pumps are attached to the engine and an arrangement made by which the driver can regulate the quantity supplied.

Formerly it was commonly thought that if water were heated nearly boiling hot it would save nearly the whole coal; but now everybody knows that the principal absorption of heat in turning water into steam is not providing the sensible heat which goes to make water feel hot, but in imparting the latent heat required to convert the liquid into a vaporous condition.

Steam Boilers.—But those who employ or are about to employ steam-engines should possess some knowledge of the boilers, for the generation of steam to supply these engines is of the first importance. Farmers will readily understand this when they consider that it is the boiler that will more resemble the horse than the engine, for it is the boiler that has to be fed with fuel, and whose goodness or badness will render the application of steam-power economical or the reverse; it is the boiler that will require the more special care of its superintendent, and which will soonest show the effect of bad treatment; and it is this same boiler that constitutes all the danger of using steam-power, for if an improper one, or a bad one, its owner may be informed of the fact by a terrible explosion.

The boiler is the real test of the power of any engine. The evaporative power of the boiler and the strength of the boiler limit the power of the engine. The size of the cylinder (within reasonable limits) has positively nothing to do with the power that an engine can exert.

"The best makers give 20 ft. of heating surface for each nominal horse-power, or 200 ft. to a 10-horse engine; and they would put on to it a 10-in. cylinder. Some makers, however, instead of giving 200 ft., would only give 140, or 130, or 120, and some even as low as 100 ft. of 'heating' surface for a 10-horse engine, and yet they will put the same sized cylinder (10-in.) on to these small boilers.

"Suppose then a farmer, knowing nothing about engines, bought from one of these unscrupulous makers a machine called a '10-horse engine,' with a 10-in. cylinder, and 120 ft. of heating surface in the boiler, and suppose the price was £5 or £10 less than the price of a 10-horse engine by one of the best makers, he would think he had done a clever thing; yet the engine he had bought would only do as much work as a 6-horse engine by a first-class maker."

It would be well, therefore, if purchasers and manufacturers would describe engines exactly according to their actual—not *nominal*—horse-power. A horse-power, as every one knows, was settled by Watt to be equivalent to 33,000 lbs. lifted one foot high per minute; and this is the real and only standard. If, then, a manufacturer declares his engines to be 10-horse power, it ought to be able to raise 300,000 lbs. (about 150 tons) through a foot in a minute of time, or, what is precisely the same thing, one ton through 150 ft., or 1 cwt. through twenty times that distance, or 3,000 ft.

The construction of the boiler, and the necessary strength it should have given to it, must be left to the maker, but it would always be well if the farmer required a written guarantee when he purchased it that it has been proved to a certain pressure without showing symptoms of any weakness; but the fact of its having been thus tested must not induce those who use it to neglect any precaution for safely working it; for the tensile strain that good wrought iron is capable of undergoing without rupture is so enormous that it will rarely give way to pressure fairly applied, as it is in the usual manner of testing, yet sometimes they explode the first time they have been used after having been so tested.

There are only two ways in which a boiler can be caused to explode, or as it is commonly called, burst. One is by gradually increasing the power of the steam in the ordinary way. It having no means of egress from the boiler it gradually increases until the plates and rivets are no longer able to bear it; a rupture of the weakest part must of course then take place. The other is when, from any cause, so sudden an increase of pressure takes place that the ordinary means provided for its liberation (as the safety-valves, &c.) are unable to act in a sufficiently rapid manner to prevent the strain the boiler is required (though only for a moment) to bear; it is to this last cause that most explosions are due; and the greatest care must be taken to prevent the circumstances arising which produce such terrible disasters.

If burnt boilers and boiler explosions are to be prevented, it is necessary that the proper level of the water in the boiler should be cautiously maintained, and especially that any lowering thereof, by neglect or accident, should not only be indicated, but remedied at once. This is an office that is fulfilled automatically by Bailey's (Ashcroft's patent) Low-water Detector and Alarm (Fig. 10), which, in its operation, is independent of mechanism, of valves, springs, floats, cranks, or other moving parts, being efficient and reliable solely through the natural effects of heat and gravitation. Its action depends entirely on a fusible plug, made of metal or alloy, which melts at the boiling point of water, or the ordinary temperature of steam, under the pressure of one atmosphere, *i.e.* at 212 deg. F. This fusible disc is so placed, that under the usual conditions it is accessible only to water having a temperature below its melting point; and whenever the water in the boiler falls below the proper level, immediate access is given to the steam, which at once melts the plugs and escapes, blowing the whistle, and sounding an alarm. This useful appliance has also a metal tube connected to the boiler by a stop-valve (this always being locked when open), and carrying an air-chamber with a half-

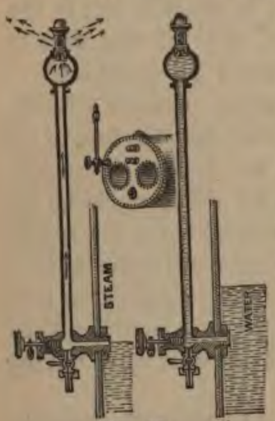


Fig. 10.

inch fusible disc, secured to its seat by an union with a whistle on its stem, and capable of bearing a pressure of 250 lbs.

The fusible plug has been applied in many other ways, but with the disadvantage of complete emptying of the boiler when requiring renewal—a manifest drawback to general use, and an objection to which the arrangement here shown is not liable, as by closing the connecting cock—accessible only with the key—and unscrewing the whistle and union joint, a fresh disc can be put in the seating, without emptying the boiler; and until this be done the whistle will continue to be sounded by the escaping steam. Thus not only is accident or injury prevented, but neglect infallibly detected by the principal or his representative keeping the key.

"*Expanding*" *Steam-Engines.*—"No farmer nowadays ought to buy any other engine than an 'expanding' engine, one in which, by means of a separate cut-off slide, the expansive power of the steam can be utilised.

"The enormous additional power to be gained out of steam simply by allowing it to expand is quite astonishing. An ordinary low-pressure farm engine is usually worked with about 50 lbs. on the safety-valve, and the slide-valve is so arranged in most of them that it does not shut off the steam until about $\frac{7}{8}$ths of the stroke has been completed. Now, if a cubic foot of water be raised into steam at that pressure, and be passed through such an engine, it would raise 3,312,288 lbs. 1 ft. high, if there were no waste and no friction. But if, instead of cutting off only at $\frac{7}{8}$ths of the stroke, we arrange our engine with a separate cut-off slide, which allows us to shut off the supply of steam when only one-third of the stroke is made, then a cubic ft. of water raised into steam at the same pressure (50 lbs. above the atmosphere), and passed through such an engine, would raise 5,558,400 lbs. 1 ft. high, if there were no waste and no friction. But, suppose again, instead of limiting ourselves to 50 lbs. pressure we make a boiler that will bear 120 lbs. on the safety-valve, and instead of cutting off at one-third suppose we cut off at one-sixth of the stroke, then a cubic ft. of water raised into steam at that pressure (120 lbs.), and passed through such an engine, would raise 8,438,109 lbs. 1 ft. high, if there were no waste and no friction.

"It is well known that the quantity of coal requisite to turn a cubic ft. of water into steam is as nearly as possible the same at all pressures. What, then, does this amount to? Why that the same quantity of water and the same quantity of coal used in an expanding engine will raise 8,438,109 lbs. 1 ft. high, whereas in one of our ordinary engines it would only raise 3,312,288 lbs. 1 ft. high.

"These figures, taken in the inverse ratio, represent the proportionate quantity of water and coal which each engine would require to do a certain amount of work. Suppose, for instance, we had a certain piece of work to do, which with an ordinary portable engine we knew took 1,000 gals. of water and 1,500 lbs. of coal to do, then, if we set an expanding engine to it, working on 120 lbs. on the safety-valve, and cutting off at one-sixth of the stroke, we should only require 392 gals. of water and 573 lbs. of coal to perform the same work!"

It need scarcely be said that a boiler properly designed for 120 lbs. steam, or even a higher pressure, is as safe as one designed with smaller margins of safety for 50 lbs. steam. The prejudices against high-pressure steam-engines are happily disappearing.

In old boilers the consumption of fuel is never less than 5 or 6 lbs. per effective horse-power; but by working steam more expansively it has been reduced in improved engines to 2 lbs. Yet, comparing this with the total amount of energy of 2 lbs. of coal, it will be found that not a tenth part of the power is obtained which that amount of coal would theoretically call into action. The theoretical energy of 1 lb. of coal is stated by Sir J. Hawkshaw as follows: The proportions of heat expended in generating saturated steam at 212° Fahr., and at 14·7 lbs. pressure per square in., from water at 212° are :—

	Units of heat.	Mechanical equivalent in foot lbs.
1. In the formation of steam	892·8	689,242
2. In resisting the incumbent pressure of 14·7 lbs. per square inch . . .	72·3	55,815
	965·1	745,057

One pound of Welsh coal will theoretically evaporate 15 lbs. of water at 212° to steam at 212°. Therefore the full theoretical value of the combustion of 2 lbs. of Welsh coal is—

$$2 \times 15 \times 745{,}057 \text{ foot pounds,}$$

or,

$$\frac{2 \times 15 \times 745{,}057}{60 \times 33{,}000} \text{ horse-power, if consumed in 1 hour.}$$
$$= 11 \cdot 2 \text{ horse-power.}$$

As the consumption of coal per effective horse-power in a good engine is 2 lbs., the power obtained is to the whole theoretical power as 1 is to 11. The average engine uses very much more coal.

Compound Engines.—The example set by Messrs. R. Garrett and Sons at Carlisle in 1880 is being followed by many other makers of agricultural engines, who are now turning out compound engines.

The judges in their report to the Royal Agricultural Society in 1880 say, "The higher the boiler pressure the earlier the steam may be cut off with advantage, and the greater the economy resulting from expansion. The gear, however, necessary for great expansion in a single cylinder is always complicated in its details, it easily gets out of adjustment, and it is rarely equal in its action at both ends of the cylinder. The compound engine with the addition of an extra cylinder enables us to get all the expansion which we desire with simple valve gear, and the losses from cooling are further neutralised by dividing the extreme range of temperature between two cylinders. The steam is admitted first to the small high-pressure cylinder to do work against its piston, and thence is exhausted at a medium pressure, then does about an equal amount of work again in the low-pressure cylinder of a larger diameter, being finally exhausted into the open air at a pressure slightly above that of the atmosphere. The general result is that by adding a small amount to the cylinder-weight of extra piston, a slide-valve, and other gear of a simple character, we can do the same work as before with considerably less steam; and as the steam produced in a given boiler is proportionate to the coal which provides the heat for producing it, the coal used, as well as the feed-water required, are reduced in exactly the same proportions.

"The most convenient sized engine for almost any sized farm would be an 8-horse boiler (160 square ft. of *heating surface)* with two 6-horse cylinders (8 in.

diameter), fitted with separate expansive slides and a coupling on the crank-shaft. Such an engine would do as much work if wanted as could be got out of a nominal 20-horse engine of the usual non-expanding pattern, and yet by uncoupling one cylinder it could be worked down as low as any ordinary 6-horse engine. It could, in fact, be made to do the work of a single horse or of forty horses at pleasure, and, if a portable engine, it ought not to cost more than a 10-horse double cylinder engine of the present pattern, say about £270; or if a traction engine, then the cost would be about the same as a 10-horse road locomotive, say about £400."

Stationary Engines.—Where there is much regular barn work, either in threshing, grinding, or food preparing, a small stationary engine will recommend itself, but it is only on large farms that fixed motive power is required for driving machinery.

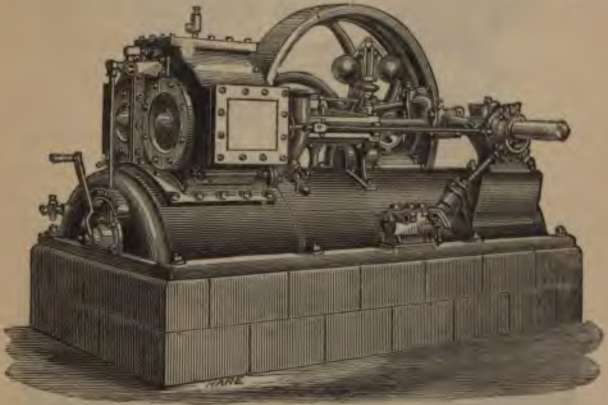


Fig. 11.

For this purpose Garratt's Horizontal Fixed Steam-engine, with compound cylinders (Fig. 11) will be found very suitable. The engine and boiler are combined, and the latter may be either multitubular or Cornish in principle, though the multitubular boiler is recommended where economy of fuel is essential, and also because it requires little or no fixing.

Portable Engines.—An engine which is merely a portable and not a traction engine is now of comparatively limited value on the farm. It answers for steam threshing, and even for steam cultivating in the roundabout system; but in either of these cases it has to be moved to and fro by horses, and for all other purposes it may as well be a stationary engine.

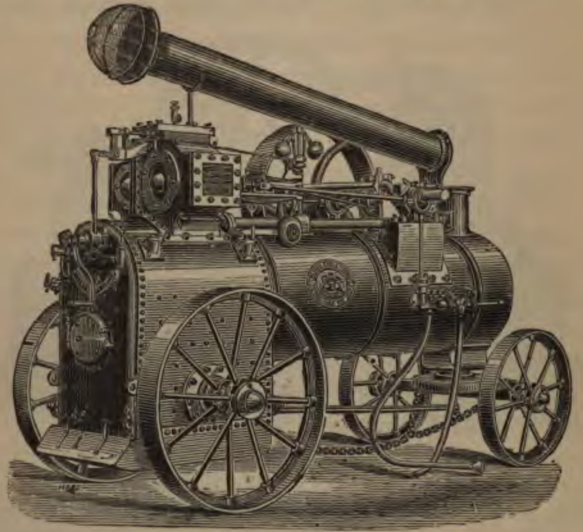


Fig. 12.

Fig. 12 is an illustration of Garrett's Compound Portable Engine.

Vertical Engines.—For light work the old horizontal fixed engine and separate Cornish boiler is now almost entirely superseded by small-power vertical engines and

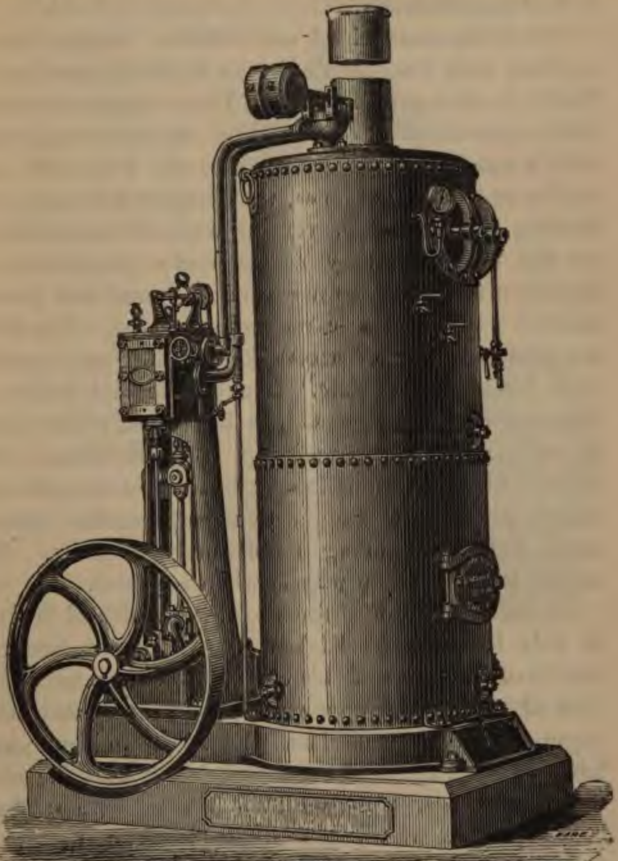


Fig. 13.

boilers combined. Among the advantages possessed by this type of engine over the old sorts are the saving of time and expense in fixing and greater economy in fuel. They are also cheaper in first cost, and less expensive to feed and maintain.

One of Ransome, Head, and Jefferies' Vertical Steam-engines, with Cochrane's Patent Multitubular Vertical Boiler, is shown in Fig. 13. These engines are especially economical in consumption of fuel, being fitted with a number of tubes similar to the boilers of locomotive or portable engines, thus largely increasing the heating surface and preventing waste of heat directly up the chimney; they consequently generate steam rapidly with great economy of fuel, and are recommended where fuel is scarce and expensive. The tubes are perfectly easy of access for cleaning and repairs, both inside and outside. The engine and boiler are mounted on a strong cast-iron bed-plate, which forms an ash-pan and also a tank for the feed-water. The boiler is fitted with double safety-valves, steam pressure-gauge, glass water-gauge, two gauge-cocks, blow-off cock, and usual firing tools and accessories. The engine is mounted on wheels when required.

At the York show of the Royal Agricultural Society, in July last, Messrs. Riches and Watts, of Norwich, exhibited an engine of this class, which attracted a good deal of attention. This was a compound condensing engine with boiler combined. Fig. 14 is an illustration. The cylinders are as shown, "tandem," with the small cylinder at top, fitted with an intermediate stuffing-box, of a form which the makers have used for ordinary inverted cylinders for thirty years. The valves are simple three-ported ones, worked from an eccentric on either side of the crank-throw, the arrangement being very simple and easy to get at. The air-pump is single-acting, and placed inside the condenser, worked by gearing about one to one and a-half of engine. The engine can in a few minutes be converted into a non-condensing compound by simply disengaging the exhaust pipe and fixing another pipe that leads the exhaust into the chimney, in case the supply of water failed at any time. The feed-pump is worked from an eccentric cast on the same cog-wheel which works the air-pump and feeds from the hot-well on top of condenser.

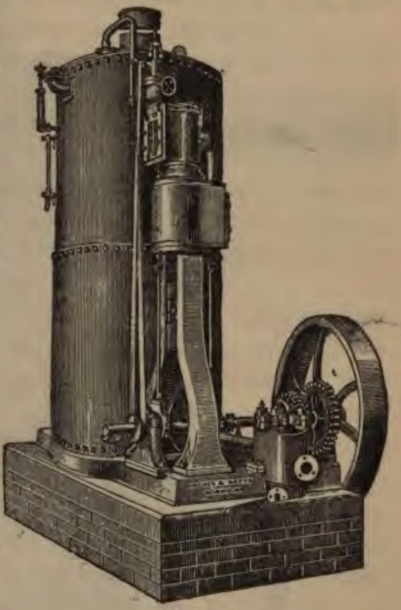


Fig. 14.

The engine exhibited was of 4-horse power nominal, working to 12-horse power indicated, with a consumption of fuel, we are informed, of about 3½ lbs. per indicated horse-power per hour.

Agricultural Locomotive Engines.—For working threshing machinery, for steam cultivation, sawing, pumping, &c., for removing agricultural produce, and in fact for all purposes to which steam can be applied as a motive power in farm work, the agricultural locomotive is far better adapted than a mere portable engine.

Fig. 15 is an engraving of one of Ransome, Head, and Jefferies' agricultural locomotive engines. These

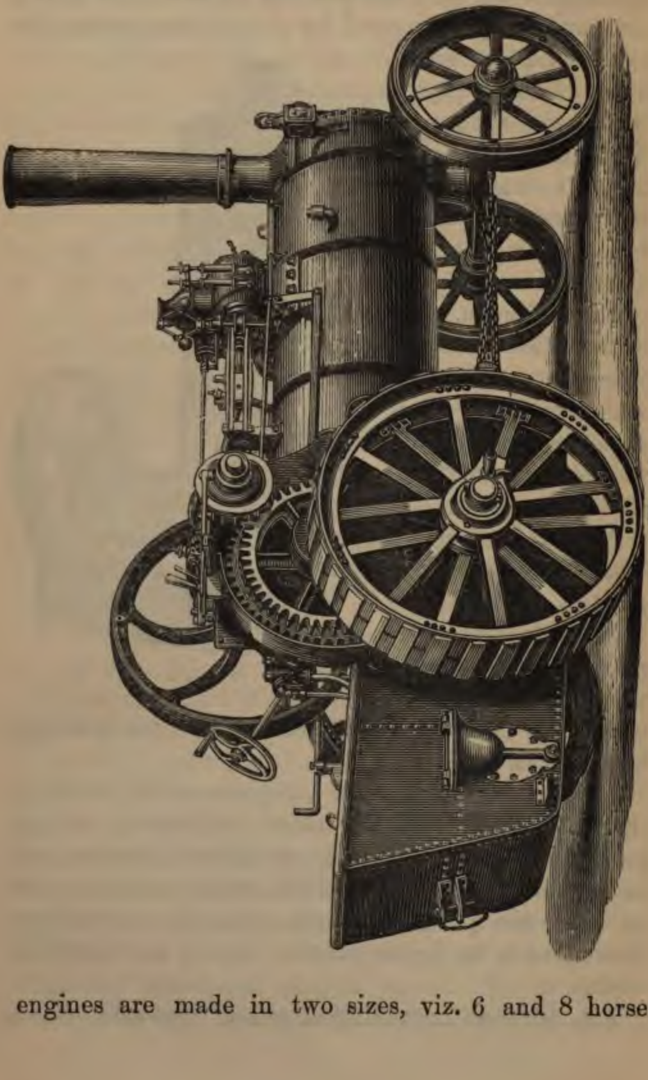


Fig. 15.

engines are made in two sizes, viz. 6 and 8 horse-power, and are arranged to travel at two different speeds, viz., about 1½ and 3 miles per hour.

They are constructed from the newest designs, and the general arrangement is the result of a long and varied experience with this class of machinery.

A winding drum working on the main axle can be fitted to these engines; and by means of a wire rope the whole power of the engine can be brought to bear upon the threshing machine, so as to draw it out of any extra difficult situation while the engine remains stationary. This is an extremely useful addition, as all those who are accustomed to them will see at once.

These engines can be fitted with double slides when required, so as to make full use of the expansive power of the steam. They can also be fitted with a new patent automatic governor, acting direct on the second expansion-slide by means of a link motion. This is a very valuable arrangement when an engine is required to drive machinery in which the load is constantly varying, at one time taking the full power of the engine and at others but a small portion of it. For sawing machinery, crushing-mills, &c., it is very useful, as only the exact amount of steam required at each instant is admitted into the cylinder, and a perfectly uniform speed is always maintained.

The Sutherland engine (Fig. 16) is a 4-horse-power locomotive, designed by Messrs. Fowler and Co. to supply a want which has long been felt by the users of our heavier engines for agricultural purposes. While the heavy engines have been proved to do the heavier work economically, they have been found badly adapted for the lighter operations, such as rolling, reaping, and carting on the farm; and hence the necessity has arisen to keep a larger number of horses than is consistent with a good system of steam culture.

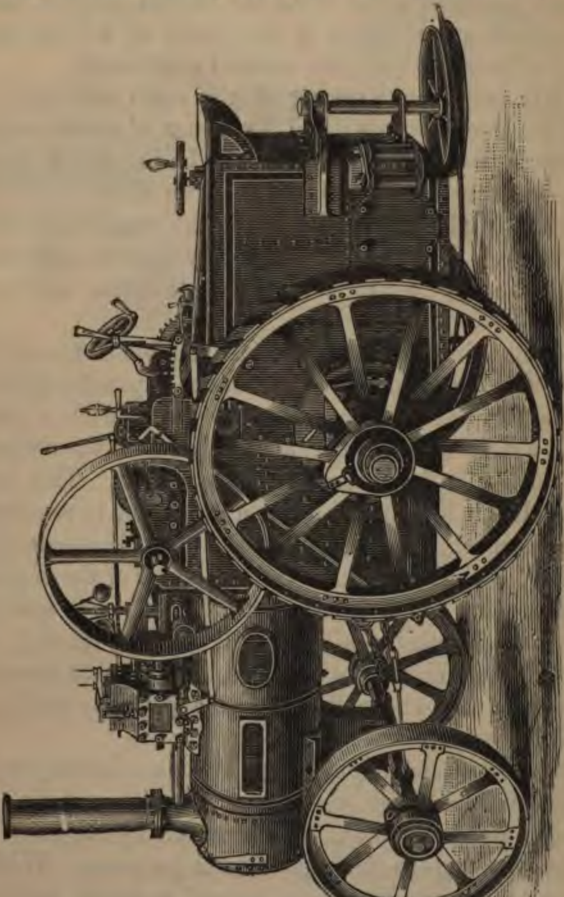


Fig. 16.

It is a patented combination of parts suitable for the purposes just mentioned, and has proved a complete success. It will pull 6 tons on the road; it will reap 3 acres per hour; it will roll 30 acres per day; it can be used for pulling a three-furrow plough on level sandy land; it will pull home the turnips and corn, and take out the dung without injury to the land; it will drive a thresher, grinder, chaffer, and pulper. To convert it into a land roller, a series of widening rings are attached to the hind wheels, and a roller of sufficient width to cover the space between the hind wheels takes the place of the fore wheels. The engine will then roll a breadth of from 8 to 10 feet. When used as a reaper, a knife-bar and delivery reel driven off the crank-shaft, are made to project from behind the traction wheel without disengaging the roller rings. The reaping and rolling in this way are secured by one operation. This engine is capable of going over any land, however soft, without injury.

Straw-burning Engines.—In field threshing by steam power, it is of the utmost importance, in countries where coal and wood are scarce and dear, that the engine employed should be one constructed to burn straw and other vegetable refuse. Fig. 17 is a section showing the working of R. Garrett and Sons' portable straw burning engine.

The straw is introduced by means of a fork in light parcels or wisps, where it is thoroughly dried before ignition, and each wisp is pushed forward by its successor into the fire-grate, where combustion instantaneously takes place; great economy of fuel is effected by the perfect drying of the straw above described, and also and consequently great ease of stoking, which is greatly enhanced by the perfect readiness of access to the grate and the tubes of the boiler, through the hopper and the ordinary fire-door placed above it.

Every engine of this class is provided with an ordinary fire-door for burning coal in addition to the hopper for straw-burning, as also with a set of the ordinary fire-bars and suitable bearers, and as the grate area is contracted, as shown in sectional view, by means of the patent combustion chamber, to the dimensions adopted for ordinary coal-burning boilers, whilst the heating surface is increased, and the combustion of the gases is more perfect, it follows that the straw-burning boilers are the more economical in the consumption of coal, whilst in respect of weight and portability the disadvantages are not material.

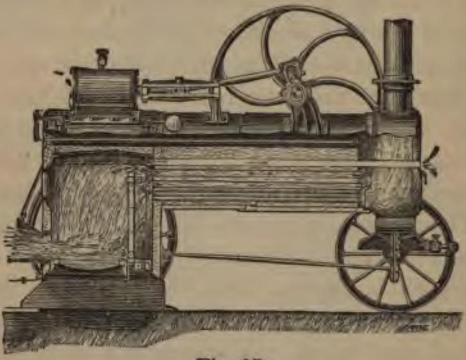


Fig. 17.

Many experiments have been tried as to the comparative values of straw and coal for fuel purposes in threshing by steam. These trials have demonstrated 3·25 to 3·75 lbs. of average dry wheat straw will evaporate the same amount of water in the same time as 1 lb. of good coal in the most modern boiler.

The amount of straw grown per acre varies very much, but in England the average may be taken at 30 cwt. per acre for wheat straw, or say 3,300 lbs.

per acre, and is worth about 30s. per ton on the farm. Consequently, the value of straw produced per acre would be about 44s.

Now, if we take the value of 1 ton of coal, at the farm, in England, at about 20s., and admit the proportion of 3·50 lbs. of straw to 1 lb. of coal, we shall arrive at the following conclusion: 3,300 lbs. cost about 44s. equals 943 lbs. of coal, cost 8s. 6d. From this comparison we find that the commercial value of straw in proportion to coal is about as one to five. It must not be supposed, however, that this comparison is applicable to every district. There are countries where the straw is of no value except for fuel, and districts where coal could hardly be obtained at any price.

The average proportion of calorific effect found by practice to exist between coal and other products used as fuel on the farm is, according to experiments conducted by Mr. Head, of Ransomes, Head, and Jefferies, as follows:—

1 lb. of good coal will evaporate 8 lbs. of water in an ordinary tubular boiler.
2 lbs. of dry peat will evaporate 8 lbs. of water in an ordinary tubular boiler.
2·25 to 2·30 lbs. of dry wood will evaporate 8 lbs. of water in an ordinary tubular boiler.
2·75 to 3 lbs. of cotton stalks or brushwood will evaporate 8 lbs. of water in an ordinary tubular boiler.
3·25 to 3·75 lbs of wheat or barley-straw will evaporate 8 lbs. of water in an ordinary tubular boiler.

Various apparatus have been designed for arresting the exit of sparks in locomotive and portable engines which work in places surrounded with inflammable substances, such as straw, brushwood, grasses, &c. Some consist simply of a cage or collector of the sparks, whilst in others water is used in order to extinguish the incandescent pieces of fuel which are blown through the tubes into the smoke-box.

Fig. 18 illustrates Graham's Spark Arrester, now being applied by Messrs. R. Garrett and Sons to their portable engines. It is thoroughly efficient and reliable, the parts being so proportioned that, though it is impossible for hot sparks to find exit, the draught through the fire is not appreciably reduced. The arrangement consists mainly of conical and annular boffle plates, made of light malleable iron, and fixed within a conical enlargement of the chimney. The cooled sparks which collect in the open space below the inverted cone are from time to time removed through the small hand-holes made for that purpose.

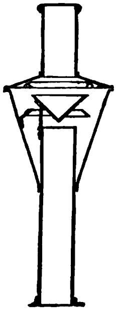


Fig. 18.

CHAPTER IV.

THE GAS-ENGINE.

THE gas-engine is pre-eminently a *secondary* power, for the reason that a portion of the latent force of the fuel has first to be converted into gas, and subsequently mixed with air, before it can be applied to produce motive power. The loss by this method is far greater than with the steam-engine, and may chiefly be summarised as follows:—

1. The *total loss of fuel* used to heat the gas retorts and calcine the coal from which the gas is extracted.

2. The loss of heat generated in the cylinder of the gas-engine, and taken off by the flow of water surrounding it.

3. The loss of heat after the gas and air have exploded, and performed their work upon the piston of the engine.

Notwithstanding, however, the greatly increased cost of working a gas-engine, it is in some cases (for small-power engines) preferable to steam on account of its greater safety and cleanliness. It must also be remembered that the gas-engine will start at full power on the gas being lit; and it requires no boiler, and does not call for constant attendance.

The "Ord" Patent Gas-Engine (Fig. 19) is a most useful and economical small-power engine.

The engraving and annexed letter-press will make the "Ord" engine understood.

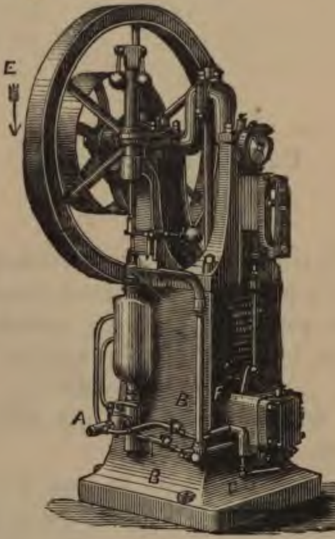


Fig. 19.

A, Main gas tap, to be turned on full at starting; B B, small gas taps, the lower one to be turned on about half, the upper one to be turned on full at starting, and then, when the engine is working properly, both these taps may be partially closed; C, burner, inside a hollow cone, at which gas must be lighted after opening B B; D, valve, to be opened a little at starting, and regulated as the engine commences working; E, fly-wheel, to be pulled briskly round in the direction of the arrow; F, gauge-cock, below which the water in tank must not be allowed to fall; G, cock, for letting water out of tank if required.

Power.	Revolutions per Minute.	Approximate Cost of Gas per Hour.	Price.	Price of Water Cistern.
Two-man . .	160	¾d.	£35	22/
Half-horse . .	160	1d.	£50	30/
One-horse . .	160	1½d.	£65	50/

CHAPTER V.

HOT-AIR ENGINES.

HOT-AIR or caloric engines are very successful substitutes for steam or gas-engines. As compared with steam-engines they have several advantages for agricultural purposes. No water is required: no boiler: no pipe connections: no skilled labour: and explosions are impossible.

The motive power in these engines is atmospheric air, which is forced by a pump into a hermetically sealed retort or generator, where it becomes heated and expanded. The pressure thus created is admitted to a cylinder, and operates a piston after the manner of a steam-engine. The heated air is discharged from an exhaust pipe, free from smoke and perfectly invisible. By a governor arrangement the "cut off" can be regulated, and the air caused to pass more or less through the incandescent fuel, or in the space above the fire, so that whilst the nominal speed of the engine is maintained, the fuel is only consumed in direct proportion to the power being developed by the engine. Additional fuel is supplied from a fuel chamber at the top of the generator, and delivered to the fire by a valve, without loss of pressure or interference with the running of the engine. The fire can be lighted and the engine started to work in about half an hour, and only a trifling amount of lubrication is necessary.

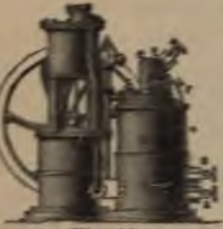


Fig. 20.

The "Buckett" caloric engine (Fig. 20) is one of the most successful engines of this class. It is a single cylinder vertical engine, and its simplicity and few working parts render any elaborate instructions for its working unnecessary.

To prepare the engine for starting, remove the doors A, B, C, and clear out from A the ashes of the previous day's working. Light a fire in the ordinary manner on the top of the grate bars, within the opening B, and place a length of stove pipe over the opening C, so as to create a draught. When the fire is thoroughly alight, remove the pipe and close all the doors A, B, C, and the engine is then ready for being started. To do this, in the case of a small engine, revolve the fly-wheel a few times; or, with a larger engine, give a few strokes of a hand pump provided with the engine for the purpose. This serves to give the first charge of air to the generator, and, a pressure being created, the engine will commence to work, and will afterwards continue to supply itself with the necessary complement of air with each stroke. Use a small quantity of *tallow* for lubricating the working surfaces of the cylinder and piston. *Oil* should not be used for this purpose, on account of its tendency to cake or incrustate by the heat; but the bearings and other working parts can be lubricated with oil in the ordinary manner. It is not necessary to feed the generator D with fuel at very frequent intervals, nor is there any advantage in using a quantity beyond that stated to be necessary to produce the power required. When the work of the engine is required to be uniform throughout the day, the time of feeding and amount of the charge should be regular. A very short experience will enable the attendant to regulate the interval and amount of feed to suit circumstances.

To charge the generator D, remove the door E, place the fuel in the opening and close the door. Turn on the cock F, to allow a small quantity of the compressed air to pass into the fuel chamber G; this equalises the pressure on both sides of a fuel valve within the chamber, so that upon raising the chain H the valve can descend and allow the fuel to fall upon the fire below. The chain can then be drawn down and the cock turned off, the pressure on the underside of the valve retaining it firmly against its seating. When this is done (which need only occupy two minutes), the engine can be left to itself, without fear of trouble or explosion.

Comparative cost of working a gas, steam, and "Buckett" caloric engine respectively, as certified by Messrs. Field, Field, and Cotton, consulting engineers. *Example* :—A 12-horse power engine, working fully up to that power 10 hours per day for 300 working days per annum.

	£	s.	d.
Steam-Engine.—6 lbs. of best steam coal per horse-power per hour, 6 × 12 × 10 × 300 = 216,000 lbs. = say, 96½ tons at 18s.	86	17	0
Gas-Engine.—The best gas-engine is stated to consume 23 cubic feet of gas per horse-power per hour, 23 × 12 × 10 × 300 = 828,000 cubic ft. at the average all-England rate of, say, 3s. 9d. per ft. .	155	5	0
The "Buckett" Caloric Engine.—Consumption, 2½ lbs. ordinary gas coke per horse-power per hour, 2½ × 12 × 10 × 300 = 90,000 lbs., which, at 14 cwt. per chaldron = say, 58 chaldrons at 12s. .	34	16	0

Bailey's Patent Hot-air Engines, on Lehmann's system, are also much used for power as well as pumping, such as chaff-cutting, churning, grinding, and crushing, also for pumping and power combined, and for general agricultural, industrial, and domestic engineering purposes.

Fig. 21 shows one of Bailey's horizontal hot-air "Driving" engines, working a chaff-cutter.

This engine consists of a cylinder closed at one end by a steel pot, and at the other by a piston. The steel pot is fixed within the stove, whilst the cylinder is surrounded by a water-jacket. The engine is fitted with a speed-governor, which may be adjusted by hand to vary the speed if required. Once set in motion it requires no attention beyond oiling once or twice a day.

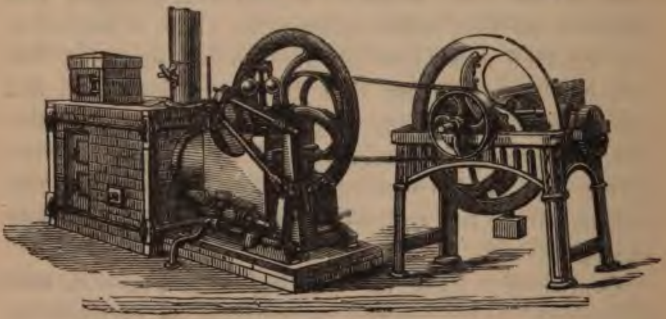


Fig. 21.

The engine is kept solely at work by the alternate heating and cooling of the air within the cylinder; the air being caused to travel backwards and forwards by a loose-fitting piston within, which is worked by the engine from the outside by means of a piston-rod passing through the front or driving piston. The air being used over and over again there is thus no exhaust and consequent smell of burning oils, &c., and there are no valves whatever to wear out or stick fast, causing expense and stoppages.

The cooling of the front end is done by a separate water vessel, connected to the "jacket" by water circulating pipes, or a small stream of fresh water under pressure is run through whilst the engine is working. In the case of circulating pipes, the hot water may be stored in a barrel or tank for domestic use. Thus the cooling requires no special attention, and no water is wasted.

The stove is provided with a roomy fireplace, holding enough fuel to keep the engine going from 3 to 6 hours without stoking. The furnace will burn almost any combustible material convenient at hand, such as wood, peat, riddled cinders; coal-gas coke, however, being preferable, as being the most economical fuel for producing and maintaining a gentle and even temperature, which is essential in working this engine; and as it consumes its own smoke it needs no attention during the intervals of firing.

The cost of working the smaller sizes rarely exceeds one penny per day.

Bailey's Caloric Pumping Engine, the "vertical" pattern, is shown in Fig. 22.

This new caloric engine has a metallic piston; the pump valves are easy to examine, and the number of working parts is reduced to a minimum, with the utmost simplicity of arrangement.

These engines are used to drive existing pumping machinery, such as is used in irrigation and kindred work. They are also employed for driving churns, and for dairy work generally, and for agricultural power requirements they are unsurpassed, and they are absolutely free from danger and are worked with the minimum of cost.

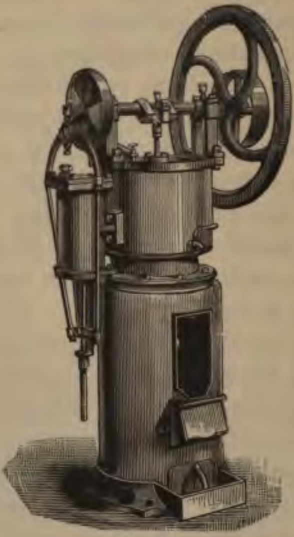


Fig. 22.

CHAPTER VI.

ELECTRIC POWER.

It has long been predicted that electricity would become the great motor of the future. But even in the light of recent successful experiments with it, we are perhaps little able to fully comprehend the future uses of this agent as a means of transmitting power and of working machines.

Many years have elapsed since sanguine electricians declared that a few plates or coils of metal and a few bottles of acid were all that ought to be necessary to drive a plough through the soil, a spindle giving motion to factory machines, a railway train across a continent, or a ship across the ocean. Everybody said that it could be done and ought to be done, but they were not so clear as to how it was to be done and made to pay.

Sir William Siemens even promised an unlimited supply of force from the falls of Niagara, and was bold enough to prophesy that not only would it some day be used to propel all the spindles of New England, but be imported, as we import wheat and pork, for the supply of the Lancashire mills when the English coal-fields became exhausted; and, indeed, so much has been heard of the possibility of using not only the falls of Niagara but, to come nearer home, the tidal fall of the Severn and other sources of water-power available in our midst, that we may well wonder why, if the schemes are so feasible, no endeavour has yet been made to utilise the vast power which is perpetually running to waste.

The cardinal difficulty has been that already indicated, of cost in proportion to result. But it would be rash in the extreme to attempt to prescribe limits to the potent agent which is so easy of transmission, and which can now be carried about stored in boxes and applied wherever force is required, either to drive plough, car, or ship, to pump a marsh or drive a pile.

The time may come when a roaring torrent on a bleak hill-side will be more valuable than a manor in the rich valley through which it flows. Then the Highlands of Scotland, the fells of Norway, the becks of Cumberland, and the waterfall districts of Wales will be the great manufacturing centres of the world; and it is even possible, should it be demonstrated that the electric-borne force is cheaper than that obtained by burning coal, that this extraordinary social revolution may be nearer at hand than is at present dreamt of.

As a means of transmitting power to a distance, the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope, as used at Schaffhausen, to utilise the power of the Rhine fall.

It is estimated by Sir William Siemens that the transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires. These, in a properly designed dynamo-electric *machine, do not* exceed 10 per cent., as shown by

Dr. John Hopkinson; and, judging from recent experiments, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in reconverting the current into mechanical effects, a total loss of 19 per cent. results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon the length and conductivity, and that due to heating by friction of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of 100—38 = 62 per cent., attainable at a distance, which agrees with experimental results, although in actual practice it would not perhaps be safe at present to expect more than 50 per cent. of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power, the loss cannot be taken at less than 50 per cent., and as it depends upon fluid resistance, it increases with more rapidity than in the case of electricity. Taking the loss of effect in all cases at 50 per cent., electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarisation; but as this second conductor need not be insulated, water or gas-pipes, railway metals or fencing wire may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products render it specially available for the general distribution of power to light machinery of every description. A loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine, of best construction, produces motive power with a consumption of 2 lbs. of coal per horse-power per hour; whereas small engines distributed over a district would consume not less than 5 lbs. We thus see that there is an advantage in favour of electric transmission as regards fuel, independently of the saving of labour and other collateral benefits.

The recent opening of the Portrush Electric Railway, practically the first of its kind, must be regarded as an event of considerable importance, not only in the history of Ireland but in the progress of electrical industry. Coupled with the remarkable results recently achieved at Grenoble by M. Marcel Desprez, it suggests great possibilities for the future, since it is now proved to demonstration that not only can force be carried by means of the electric fluid, but that the motive energy can be generated at a distance and applied directly where it happens to be required. Several months ago M. Desprez conveyed a ten-horse power through a wire nearly 23 miles long. The result was, however, only obtained by a large expenditure of steam-power in generating the force.

More recently he has been successful in proving that by the utilisation of the waterfalls running to waste, power enough could be obtained to make the new method of working machinery and supplying light perfectly successful. Employing a mountain stream at Vizille, $8\frac{3}{4}$ miles from Grenoble, as the initial source of the energy, he was enabled to convey through a very light wire a seven-horse power, representing when it arrived at the end of its rapid journey 62 per cent. of the force taken at the fountain head at Vizille. This power, so cheaply obtained, is moving in Grenoble several printing and other machines, lighting 110 Edison lamps, and generally holding out a brilliant prospect of what may be soon accomplished in other towns so happy as to be in the vicinity of a waterfall, or even of the sea, the tide being used as a generating power.

The railway from Portrush to the Giants' Causeway is 6 miles long, and the force to work it is generated by a waterfall in the river Bush, with an available head of 24 ft., the electric current being conveyed by an underground cable to the end of the tramway. The water-power passing through turbine water-wheels, which utilise the whole force of the fall, is said to amount to ninety horse. It is obvious that for a light train of tram-cars there is enough and to spare. The practicability of such a line is now a settled matter. The only question is whether it is likely to pay as a commercial venture. Considering that the initial power costs nothing and that coal in Ireland is dear, there are good hopes that a line certain to be freely used by tourists will satisfy the expectations of its projectors.

Taking, as the basis of their calculations, the expense of working a steam tramway engine at Portrush, it is claimed that while the old system cost on an average £8 4s. 9½d. for the engine per week, the electric cars can be run with the same number of passengers for nearly £2 6s. less.

The electricity generated at the waterfall is at once conveyed to the railway through an insulated wire. It is then carried along by the side of the tramway through a conducting rail, which is carried at some distance above the ground and supported on insulators. An arm, with a brush or pad at the end of it, stretches out from the train and keeps contact with this conductor, thus conveying the electricity to the machine which it has to work upon the car. In this way a sufficient and constant supply of force is kept up from the outside, and the car is not obliged to carry with it the ponderous accumulators with their stored supply.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and fields from one centre. Sir William Siemens has worked such a system, in combination with electric lighting and horticulture, for some years, and he speaks with confidence of its economy, and the facility with which the work is accomplished in charge of untrained persons.

The application of transmitted electric energy to agricultural implements and machines of almost every description, is, indeed, a very simple matter. No gearing is necessary, a single insulated going and return wire serving to convey the power from the dynamo to an electro-motor attached directly to each machine. In this way the driving power for a threshing-machine, a chaff-cutter, a root-pulper, a corn-bruiser, and even for such field implements as the plough and the drill, can be brought from any distance with little or no loss of effect.

There are certain classes of agricultural machines which it will, perhaps, be more convenient to work by means of stored electricity. Two years ago the storage of electric energy in black boxes, and their power *taken out of* them, by Sir William Thomson, may have appeared visionary to many, but to those who could foresee the possibilities connected with the electrical storage of power these experiments of Sir William Thomson were of pre-eminent importance.

"The two latest employments of electricity, stored in Faure-Sellon-Volckmer accumulators, are in the boat *Electricity*, which many may have seen running at Kew, and the electric tricycle of Professors Ayrton and Perry. In the tricycle no work is done by the rider, but little black boxes, carried on the base-board, contain the stored electric energy, pretty much in the same way as a horse's body contains its breakfast of oats and hay, with the difference that with the accumulator it is the receptacle which has weight, so that neither in receiving its feed in the morning nor discharging its power during the day, does the accumulator gain or lose in its weight. By means of a tap, the rider can turn on more or less electricity, and go faster or slower."

The time, we imagine, is not very distant, when the ploughman will be seen riding on his plough with one or more days' store of electric energy under the seat, and the implement he steers turning over the soil with a speed, ease, and economy that immeasurably distances even the best performances of the steam-plough.

Professor Ayrton predicts a time when electric power will be supplied, as gas is now, to houses for lighting purposes; and when this has been accomplished, the same wires that convey the electricity for lighting will be employed to convey the power to work electro-motors to turn domestic machines.

It has been found impossible to supply by steam or gas-power a compact and practical engine to drive a sewing-machine, a small lathe, a fan, a rotary knife-grinder, a boot brush, or any of the thousand household machines which require but a small power. For such purposes, however, the little "Griscom" electro-motor is admirably adapted and is already extensively used.

The apparatus in question is, in fact, a cheap, compact, and effective household engine, consisting of a small electro-motor, which can be adapted to drive any sewing-machine, together with a battery in a box, containing a supply of electricity sufficient for several months' work. The motor is a tube of soft iron wrapped with insulated copper wire, with a segment left bare on either side. The ends are closed by brass plates, which are at the same time the bearings of a small "Siemen's" armature which revolves inside the tube. The current is brought to the commutator of the armature, *i.e.* the part where the ends of the wire are fixed, by two light springs bearing rollers, which revolve against the commutators. The current is brought to two binding posts in connection with the rollers. As soon as a current is set up the armature revolves with great speed (up to 5,000 evolutions per minute) and with much power. The name "double induction" is given to the apparatus by reason of the ingenious way in which the induced or secondary currents are utilised instead of acting as a brake. By a reversing attachment the motion of the motor can be reversed while running at full speed.

These motors are made from ¼ man-power to 1 horse-power. By combining a definite number of motors, any machine power required can be obtained.

A "Griscom" motor, weight 2½ lbs., of about ¼ man-power, for driving small machines, costs about £3. A 1 man-power motor, weight 6 lbs., costs £7. A 1 horse-*power motor,* weight 40 lbs., costs £25.

The Electro-Dynamic Company, who are the manufacturers of the "Griscom," have perfected a bichromate battery, which is adapted specially to their motor. It consists of a six-cell bichromate cell in a strong locked box with a pedal, which, without any effort on the part of the operator, lowers the plates into the liquid, and at any desired depth, thus regulating the speed. A spiral spring lifts the plates out of the liquid, which emits no fume or smell, and the battery does not therefore waste when not working. The life of the battery depends on the charge, and can be indefinitely prolonged by renewing the chemicals and zincs.

A six-cell automatic battery, with carbon zincs complete, and spring and lowering attachment, costs £3 4s. A twelve-cell battery, for 1 man-power battery, complete in box, costs £9.

Large motors are most economically driven when they receive the current from a dynamo-machine.

Clarke's Patent Battery dispenses with dynamo-machines and accumulators, which need recharging, and enable the motor to be kept up by refilling the batteries with a simple chemical compound.

CHAPTER VII.

HORSE GEAR.

THE employment of horses for working threshing-machines and other barn or food-preparing machines is not now nearly so common as formerly, it being considered, on all but very small farms, that the work can be more economically performed by means of a small-power portable steam, hot-air, or gas-engine. When this is the case, the favourite method of transmitting power is through belting, or by means of a driving shaft, instead of toothed wheels.

Very expensive horse-wheels were formerly constructed of substantial and durable character, and fixed in an appropriate building. They are of two kinds, the overhead and the underfoot wheels. The diameter of them is often made equal to the entire diameter of the horse-walk, and toothed on its outer edge. The speed is at once got up by this means, but it is exceedingly irregular in its action, and is a dead pull for the horse, there being no intermediate parts to equalise the strain by their elasticity, which is necessary to animal labour. The manner of yoking horses when employed in this way is of considerable importance, as the horse is always exerting himself in a direction tangential to the circle of his walk; the animal, therefore, should *draw by* a swing-tree instead of a yoke, attached to a beam over head. In the case of one horse hanging back and leaving the others to do his work, an arrangement has been made which effectually prevents it. The principle of the arrangement is, that the ring-chain forms a figure of as many equal sides or angles as there are horses in the wheel, and that the angles shall always remain equal; by this means every horse is compelled to bear his fair share of the load.

None of these horse-wheels are ever now erected, a portable description having taken their place. The modern horse gears possess, owing to their being self-contained, portable, and easily fixed in any desired spot, merits which do not belong to the old-fashioned horse gears, with the large overhead first-motion wheels.

There is still a very considerable use of horse gears on English farms, as is evinced by the large trade done in them, as shown at exhibitions of agricultural machinery.

On all farms where steam-power is not at command, the farmer must fall back upon horse gear for operations of daily occurrence, such as preparing food. Nay, even where steam-power is used, we are convinced that horse gear, for certain operations, may be economically employed. For example, the pulping of roots should be a daily operation, as their virtue depends materially upon their freshness. It would be a costly business having to use steam for this purpose, one horse (or pony) an hour or two being sufficient.

In Fig. 23 is given an illustration of Crowley's Patent One-horse Gear, without cover to show the working parts. This horse gear was awarded a silver medal by the Royal Agricultural Society at Carlisle in 1880, where it was severely tested on the Dynamometer, and though only for one horse, stood the test of transmitting four-horse power. It is fitted with safety clutch for stopping the pole when the horse stops.

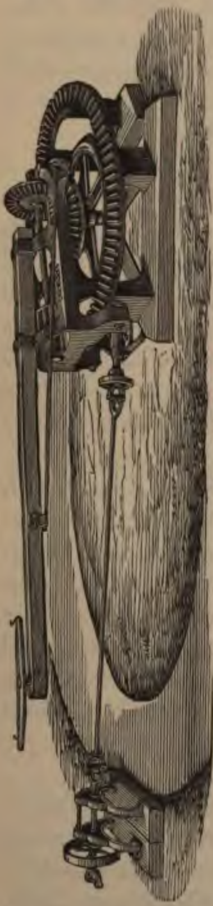


Fig. 23.

In this gear, the main wheel forms the frame, the bevel teeth of which face upwards. Under the rim are six supports which rest upon the arms, all of which are cast together and form one compact wheel and frame. From the centre boss of the wheel is fixed an upright shaft, upon which is placed a double bevel wheel and pinion, the large wheel of which acts upon and turns the bottom horizontal shaft, which runs in two bearings formed on the frame or arms of main wheel. Upon the upright stud or shaft rising from the centre is placed a horizontal carrier, upon which is fixed the draw-bar or pole to which the horse is attached. This carrier turns round upon the stud when propelled by the horse, and gives motion to the double wheel pinion on the centre stud by means of a shaft which has keyed upon it, at the outer end, a pinion which runs upon the main wheel, and a wheel at the other end, which acts direct upon the pinion of the double wheel, every wheel being so placed that the friction is taken off one wheel by the action of the others. It has a small intermediate without wheels; but having a short shaft fitted with shackle, joint, and one pulley, connected in the usual way to the gear with joints and pins. Its leading points are strength, easy working, and speed; one turn of the horse gives 37 revolutions, or at the rate of from 100 to 120 revolutions per minute. The price varies from £8 upwards according to horse-power.

Bamford's Improved Patent Safety Two-horse Gear, with spring racket, especially designed for preventing accidents to horses, is shown in Fig. 24. This, also, is a very complete, strong, and safe horse gear. The main driving-wheel is 44 ins. diameter, and is made without any openings or spokes, so that it is impossible for an animal to get its feet entangled in the gearing. The framework is most solidly constructed, and consists of two castings only, with four pillars, thus having great strength and durability. This gear makes 7 revolutions to 1 of the horse, and 43 revolutions with intermediate motion attached.

Endless-Chain Power.—Fig. 25 shows an improved horse-power of the kind, so extensively used throughout America on farms of moderate extent.

"The power of these machines and the amount of friction in running them may be ascertained by the rule for determining the power of the inclined plane, for the only difference between the endless chain and a common inclined plane is, that in one the plane is fixed and the body moves up its surface, and in the other the plane itself moves downward, and the weight or animal upon it remains stationary. The same principle applies in both cases.

"First, to ascertain the friction, let the platform be placed on a level with the horse upon it; then gradually raise the end until the weight of the horse will just

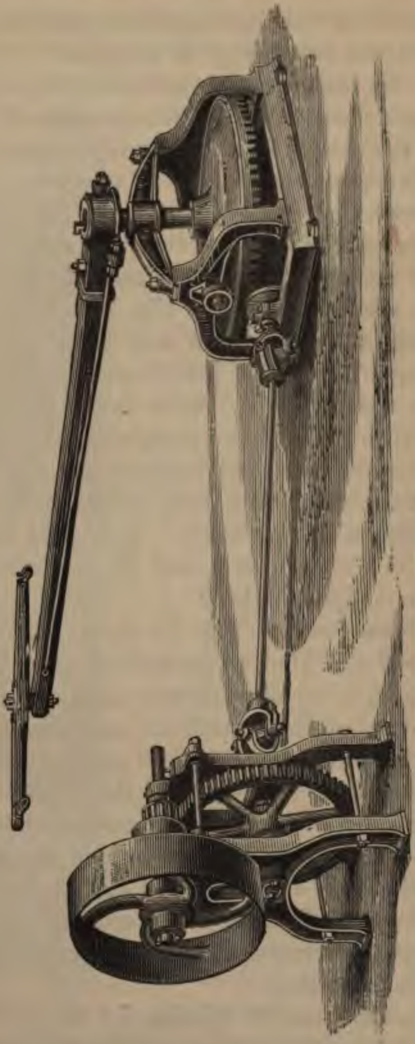


Fig. 24.

give it motion. This will show the precise amount of the friction; for if the end be elevated one-twentieth of its length, then the friction is one-twentieth the weight of the horse and platform.

"Secondly, to determine the power when the end is still further raised, measure the difference between the height thus given and the length of the platform. If, for instance, the height of the inclination is one-eighth of its length, and the horse is found to weigh 800 pounds, then the power is 100 pounds, or one-eighth the weight of the horse."

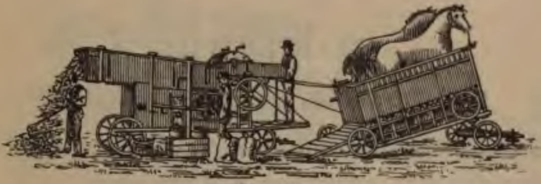


Fig. 25.

The tread power is successfully applied to churning and other light operations in which the weight of a sheep or a dog suffices to drive the machine. A sheep is more convenient than a dog for the purpose, as it is heavier, more quiet, less averse to the labour, and when the task is done, it is turned into the yard or pasture where it is readily found next time.

CHAPTER VIII.

DYNAMOMETER, OR DRAUGHT GAUGE.

THIS is a simple instrument for testing the draught of ploughs or other implements and machines.

As an example of the utility of the dynamometer, the farmer may wish to choose between two ploughs which, so far as the eye tells, may do their work equally well; but this instrument, when applied, may show that the team must exert a force of 3½ cwt. to draw one of them through the soil, while the resistance of the other is only 3 cwt. If other things were equal he would therefore select the one of easiest draught, and save the labour of his horses. The same advantage may be derived in the selection of harrows, cultivators, chaff-cutters, threshing-machines, and all other machines worked by men or by horses.

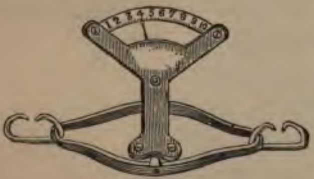


Fig. 26.

It is found that a pair of ordinary farm horses, walking at the rate of 2½ miles an hour, will work an implement, the resistance of which is about 3 cwt.

Fig. 26 is an engraving of Howard's Dynamometer or Draught Gauge, which will be found exceedingly useful for the purposes above mentioned. The end of this instrument is hooked to the implement, the other to the whippletree; and, as the horses draw, the spring is collapsed, and the draught is indicated on the dial. The price of the instrument complete is £3 5s.

The Self-recording Dynamometer, shown in Fig. 27, has also been designed by J. & F. Howard for the purpose of ascertaining the draught of ploughs, mowers, reapers, and other implements or machines. The self-registering apparatus gives the exact draught, and also indicates the oscillations which have taken place. This instrument is of special value to agricultural societies requiring to ascertain with great accuracy the draught of various implements or machines.

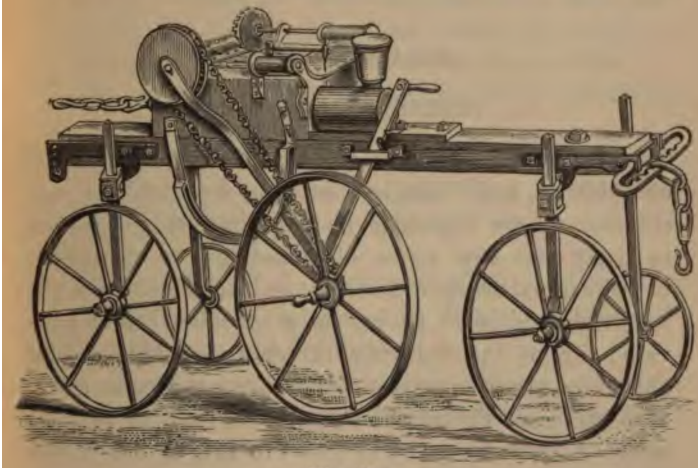


Fig. 27.

CHAPTER IX.

THRESHING-MACHINES.

THRESHING-MACHINES are classified as "double blast" or finishing, and "single blast" or non-finishing machines. There is perhaps no single machine designed to carry out any series of operations or processes, in which so many conditions and circumstances are involved, and have to be fully considered and provided for, as the finishing threshing-machine. Not only does every country produce even the same grain with straw of different lengths, with varying proportions of grain to straw, of grain to ear, of beard and chaff to ear, and with different proportions of weeds and seeds in the crop; but the circumstances of dry and wet seasons, and of heat or cold, affect the conditions under which the threshing, cleaning, and separation of the grain and seed can be effected. In England, threshing is performed at almost all times of the year; and the crop is consequently in different states of dryness, depending upon the season and weather when it is threshed, the time it has remained in stack, the part of the country in which it is grown, the situation in which the stack has been placed, and, if threshed directly after harvest, the amount of rain and of sunshine during harvest. In most foreign countries it is threshed when harvested, and is consequently very often extremely dry and very brittle; while the quantity of weeds grown and collected with the crop is sometimes more than the crop itself.

These facts give a faint idea of the chief causes of the manifold difficulties and conditions involved in producing successful threshing-machines; these will, however, be better appreciated when the details by which these difficulties are overcome are described.

The primary operations performed in threshing are—

1. Separation of the grain from the ear and straw.
2. Separation of the grain from short broken straw and pieces of broken ear (cavings and chobs), and from the chaff.
3. Separation of the grain from dirt and seeds.
4. Separation of the grain into different qualities.

In most countries these involve—

1. Threshing the whole crop, with greater or less length of straw, and passing it between a fixed or a rapidly revolving ribbed surface.
2. Shaking the straw, to remove any grain, seeds, chobs, and chaff that may be carried by it.
3. Passing the whole of the products of threshing, except the straw, over rapidly reciprocating riddles and sieves, in presence of the blast from one or more fans.
4. Passing the grain through a cylinder provided with revolving beaters or arms, to remove any firmly adhering chaff, awns, or beard, followed by final sifting on secondary sieves.
5. Passing the grain through a revolving screen.

The principle and operation of the modern threshing-machine is very clearly shown in the longitudinal section (Fig. 28) of one of Marshall's machines.

One of the chief differences between the early and

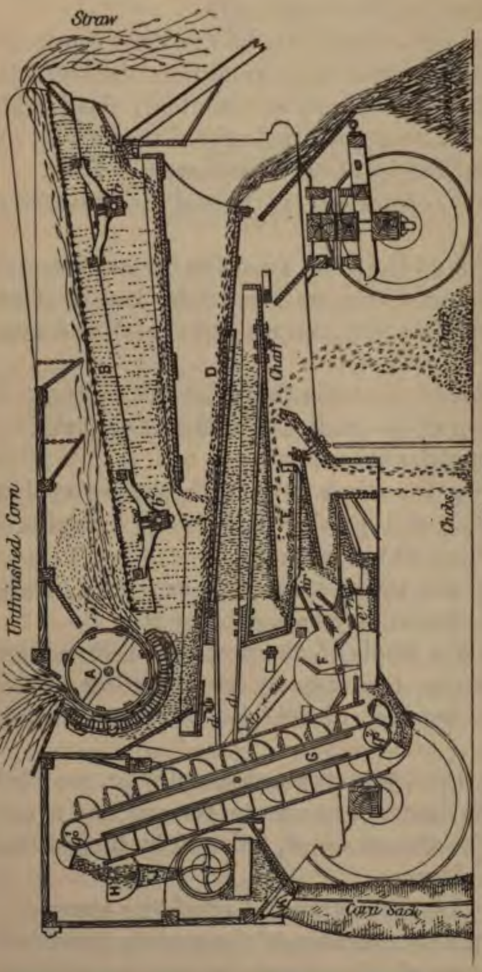


Fig. 28.

A.	Drum.	F.	Fan.	e.	Lower sieve.	J.	Rotary screen.
B.	Straw-shaker.	b^1. b^2.	Crank-shafts.	e^1.	Corn-shoot.	K.	Corn-spout.
C.	Shog-board.			G.	Elevators.	g^1. g^2.	Pulleys.
D.	Caving-riddle.	d. d^1.	Connecting rods.	H.	Smutter.		
E.	Dresser.			I.	Second blast.	j.	Spout leading to screen.

modern threshing-machine is in the construction of the drum and the speed at which it works. In the early machines, the cylinders, or drums as they are called, which carry the beaters, moved at a velocity of about 250 revolutions per minute: in the present machines the drum makes quite a thousand revolutions per minute.

In the old threshing-machine the corn was fed in between two fluted metal rollers which retarded the motion of the sheaf whilst the beaters on the circumference of the drum were knocking out the grain. In the modern machine, the rollers are altogether discarded. There is an iron concave grating, made to agree with the sweep of the beaters, from which it stands about $\frac{1}{4}$ of an inch. The sheaves are fed loosely into the space between the grating, and the quick revolving drum and the scrubbing action are sufficient to free the grain from the straw.

The straw-shaker separates the grain from it most effectually, and can also be made to send forth the straw straight and unbroken, which is an important matter when it has to be sent to market instead of being consumed on the farm, and even in the latter case the "shakers" save waste.

The shakers receive their motion from one or from two cranks. The width of the shakers is usually about equal to the length of the drum, their length being about double that of the drum. A considerable stroke is necessary for a shaker crank, in order that the shaking of the straw may be sufficiently violent to effect the complete separation of the grain from the straw. An average throw of the crank is 4·25 in. with 345 strokes per minute, or 0·0203 of drum surface speed.

After passing the first dressing apparatus in which the cavings and short straws, the chaff, the chobs, and the small seeds of weeds, sand, &c., are separated, the corn is carried to the top of the machine by a cup or blast elevator, whence, after passing through an awning and smutting apparatus, it comes down into a second dressing apparatus, consisting of at times a rotary screen, at others of a series of riddles or sieves, through which the corn percolates while being acted upon by a blast which carries away the beards, chaff, smutt, &c. A separate spout conveys refuse of all kinds to the ground. No good grain can escape, and the screen separates it into three qualites, the size of the corn in each being determined by the adjustment of the wires.

In the most improved machines, a single high-speed fan or blower is attached to the drum-shaft, from which the necessary blasts of air are conducted through separate channels and brought into contact with the chaff and corn at different points. The pressure of these several blasts of air is regulated by simple valves under the control of the attendant, and can be modified to suit any kind of grain under operation. By thus dispensing with a second fan, the necessary number of spindles, bearings, pulleys, and driving belts, as well as the wear and tear, and bulk and weight, of the machine, are all reduced to a minimum.

The "single blast" machine has no second dresser, and does not finish for market. It remains much the same as it was many years ago; but is now only in favour with farmers who thresh for the granary, or before their corn is in a fit state for marketing.

Messrs. R. Garrett and Son, of Leiston Works, Leiston, have recently produced a novelty in their rolled steel reversible drum-beaters. The primary object of this invention is the provision with every threshing-machine of the equivalent of a new set of drum-beaters, as these, when worn on one side or face, can be reversed. Another feature is as follows: The drums of threshing-machines are commonly composed of eight ribbed beaters in which the ribs run upon the surface of the different beaters alternately from right to left, and *vice versâ.* In the new beaters the ribs run on one side or face from left to right, and on the other side from right to left, so that with one set of rolls the needful beaters for a drum can be produced. It is, further, a matter of considerable convenience to the

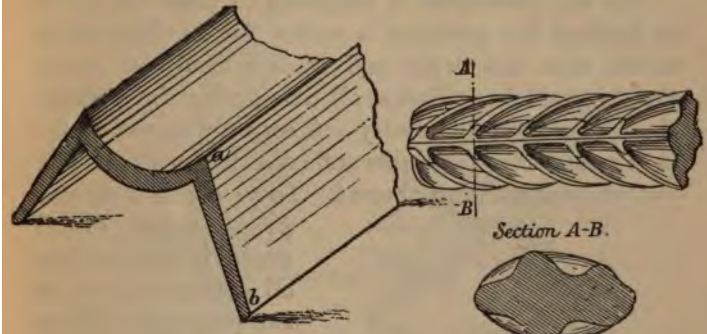


Fig. 29.

owners of threshing-machines to have beaters which are thoroughly interchangeable, so that a smaller stock of costly wearing parts is necessary in order to be provided against occasional accidents. In carrying the invention into effect, the principal difficulty to be contended with was the provision of a suitable bed for the reversible beaters in the surface of the drum. To this end continuous rolled steel chairs are employed of an inverted ⊔ section, hollowed on the top surface to receive the beater, from which it is parted by means of a strip of papier-mache, and having the legs set at a suitable angle (of about 135 deg.) to the radius of the drum to project the corn against the concave surrounding the drum, where it is further operated on by the ribs of the beaters proper. A principal feature in the construction of the combination of the chair and beater is the depth of threshing surface, A B, which permits of a slower speed of drum than heretofore without incurring the danger of "winding" the straw or failing to thrash clean. Fig. 29 shows the arrangement perfectly.

For the prevention of accidents to those employed in feeding the machine, a recent Act of Parliament enacts that the drum and feeding-mouth of every threshing-machine shall at all time during the working thereof be kept sufficiently and securely fenced, so far as is reasonably practicable and consistent with the due and efficient working thereof. There are now several patent safety drum-guards in use, but they all depend on one of two principles. "Some makers think with R. Garrett and Sons that there is no danger of accident to the feeder so long as he is in his box; and it is only when he is out of it that there is any possibility of his falling into the drum. Their guard (Fig. 30) consists simply of a cover, which always remains closed over the mouth of the machine until the feeder gets into his place, when his weight depresses the bottom of the box

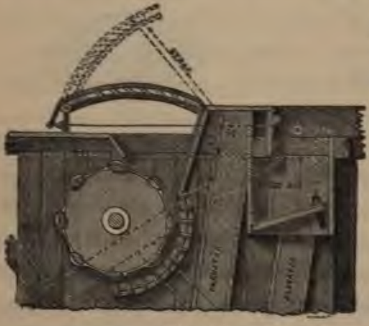


Fig. 30.

a little, giving movement to suitable levers, and opening the mouth of the machine. Other makers arrange matters in such a way that if any undue pressure comes, either upon the feeding-board, or a curved hood which covers half the drum opening, the latter is instantly closed by a self-acting shutter or flap." (*Pidgeon.*)

The latter principle is illustrated in Ransome's Safety

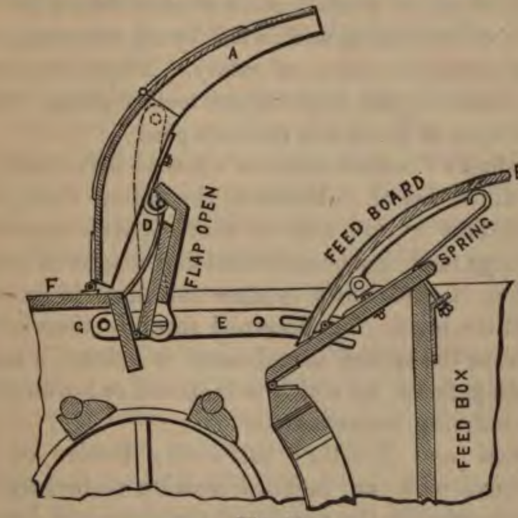


Fig. 31.

Drum Guard (Fig. 31). It is so constructed that it is almost impossible for any one to fall into the drum of the machine, as will be seen by reference to the drawings. A self-acting flap, or shutter, which, when down, completely closes the mouth of the drum, is so arranged that when open it does not interfere with feeding the machine, but will drop instantly and close the drum if any one falls either on to the hood A or feed-board B. Sweepings can be swept into the drum as usual, and the guard can be easily applied to old machines at a small extra cost.

Several makers of threshing-machines have sought to combine with the drum-guards a self-feeding apparatus. The first of these was brought out by Wilde, of Reading, in 1871, and has since been adopted by Clayton and Shuttleworth, and other makers. It consists, in effect, of a small straw-shaker, which delivers into the drum mouth, and is fed by an attendant, who himself stands in a place of safety. Above the shaker hangs a spiked rake, under whose teeth nothing thicker than a layer of grain can possibly pass.

Marshall's Feeder consists of a spiked barrel fed from an inclined board. Beneath the latter three saw-toothed discs revolve, and the board itself is suspended by springs in such a manner that the weight of a sheaf depresses it sufficiently to allow the discs to protrude and cut the band. The loosened sheaf is then carried forward to the spiked barrel, until it reaches a line of oscillating forks, by which it is spread out evenly just before entering the concave.

Ruston and Proctor's Self-acting Feeder consists of a box, with an inclined feeding-table arranged in it, placed over the mouth of the drum and forming a large hopper into which the corn is thrown. At the farther end of this table there is a revolving hexagonal drum, provided with obtuse teeth which pick up the corn and carry it forward to the threshing-drum as fast as it can be supplied, whilst a number of vibrating tines arranged above split up the sheaves and effect an even distribution across the whole width. The feeding-table is supported by a self-acting spring with disengaging gear, which instantly stops the motion of the feeder in case any person falls or steps into it, and prevents any injury occurring.

Self-acting feeders have not yet been very generally adopted; but ultimately no doubt they will. They secure a full and uniform supply of corn to the machine, save labour in hand-feeding, and dispense with drum guards.

The following detailed description of Ransome's threshing-machine is from a paper read before the Institution of Mechanical Engineers by Mr. W. W Beaumont, in 1881.

This machine, of the size having a 4 ft. 6 in. drum, is illustrated by Figs. 32 and 33. This is only one of many different sizes and arrangements of machines made by this firm, according to the practice of all makers to suit the requirements of all countries. The arrangement and the purposes of the parts will be best understood by following the straw, &c., through the machine.

Fig. 32 is a longitudinal sectional elevation.

Fig. 33 is a transverse section of the machine at the hinder end, taken through a line a little within the end framing and looking from behind.

The man feeding stands in the feeding-box A^1, Fig. 32, and the sheaves of corn, after the binders have been cut, or the corn of whatever sort in a loose form, is handed to him by other workman standing on the top or platform of the machine. The feeder then passes it into the drum mouth A, with as much regularity as possible, over the feeding-board A^2, it is then caught by the drum B, and rapidly carried between it and the concave B^1. The grain is knocked and to some extent rubbed out of the ear, and the ear more or less broken and separated from the straw, as it passes between the

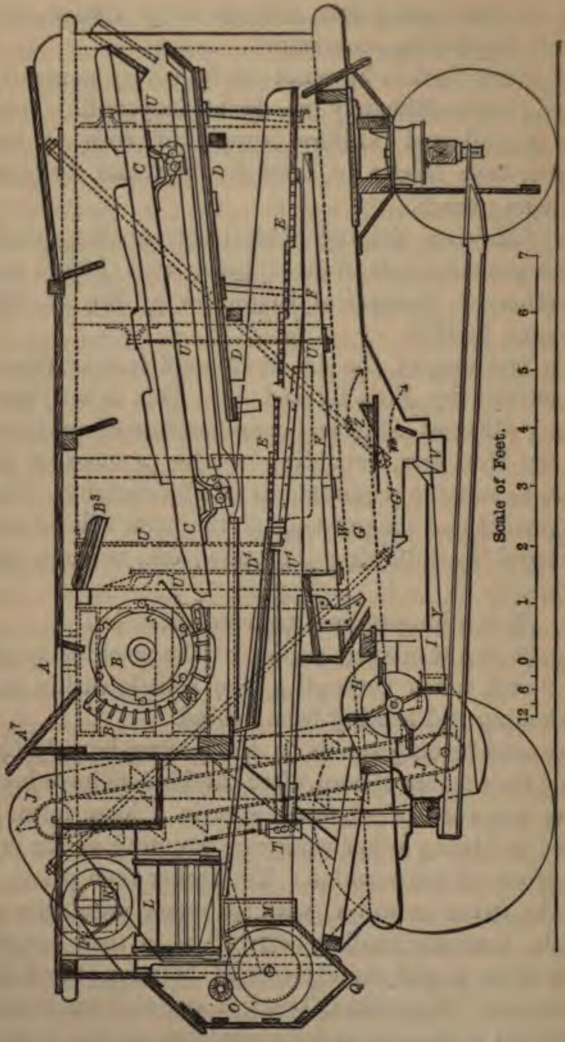


Fig. 32.

drum and concave; most of the grain falling through the concave grating and the rest passing with the straw on to the shakers C; the straw carrying with it some grain and a good deal of the chobs and cavings. All these are shaken from the straw on the shakers, and pass through on to and down the oscillating-board D, whence they pass on to the upper part of the riddle surface E. The greater part of the grain, seeds, chaff, &c., which fall through the concave, passes on to the oscillating-board D^1, and thence also on to the riddle surface. The straw, from which all grain, &c., has now been separated, passes upwards and falls over the upper end of the shakers; while the grain, seeds, chaff, and chobs pass down to the bottom of the oscillating-board F, most of the small seeds and dirt being

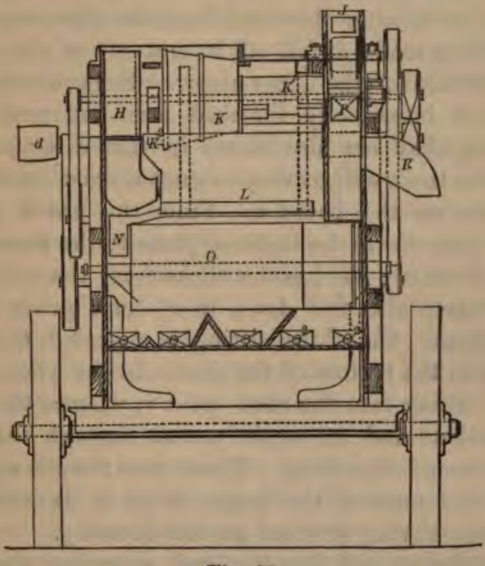


Fig. 33.

separated in the passage thereto by falling through the perforated plate or sieve over the spout W, which carries them away. The remainder of the material, including all the grain, chaff, chobs, and some seeds, passes to the end of the board F and falls down the inclined board X on to the upper sieve G. Through this sieve most of the grain falls to the bottom of the shoe at Y, a blast of air from the fan H assisting in the sifting by blowing the chaff from the sieve, especially that which tends to fall off its end out of the shoe in the direction of the upper arrow. Some of the small pieces of imperfectly threshed ears and grain with adhering chaff are also blown in that direction; but owing to their weight they are not carried beyond the stop bar on the board Z. From the board Z these chobs pass down the inclined plane to the second and lower sieve G^1; the heavier chobs from the end of the upper sieve also fall down to G^1, some grain falling with them. On G^2 the sifting is repeated, the grain falling to the bottom of the shoe, and the whole of the chobs falling into the chob-spout V, whence they drop into baskets and are again passed through the drum for a second threshing. There now remain only the grain and some of the larger seeds to be dealt with, the grain having received its first dressing.

For the second dressing and screening the grain passes through the spout I to the bottom of the elevator-box, and is thence taken by the cups of the elevator J to the top of the machine, and delivered into the cylindrical part K^1 (Figs. 32 and 33) of the awner. When, however, the grain is remarkably uniform in quality, and the crop very clean as regards freedom from weeds, and when it is intended to dress the corn (if *that is further* necessary) in a dressing-machine, the grain is allowed to pass at once out of the machine from the elevator spout to the sack spouts Q; for which purpose a slide shown in Fig. 32, at P, is provided. The same remark applies when beans are threshed. From K^1 (Fig. 33) the grain is passed by the revolving arms therein through the awner K, in which any firmly adhering chaff is rubbed off the grain and the smut balls broken, and thence it falls through the spout K^2. From K^2 the grain drops on to the upper sieve in the second jog-shoe L, Fig. 33, and is successively sifted by the several sieves shown in cross section in Fig. 32, the larger seeds and any stones being rejected and passed down the spout M, while the grain goes through the spout N into the rotary screen O. At H (Fig. 33) is a second fan from which a blast is directed between the sieves in the jog-shoe L; and by this blast all dust (some of which results from the broken smut balls) and the chaff or beard which has been rubbed off in the awner is blown off through the dust spout R (Fig. 33). In the screen O (Fig. 33) the smallest corn drops at once through the spouts Q Q, and forms the third quality. The grain next in size drops through the spouts Q^2 Q^2.

To provide room for the men working on the top of the machine in attendance upon the feeder, the platform is increased in width by boards not shown in the diagrams, but which are hinged to the top edges of the frame and supported at their extremities by struts resting on the bottom members of the frame.

The drum B in this machine (Fig. 32) has width of 4 ft. 6 in., and consists of six beaters mounted upon iron-faced beater-bars, which are fastened by hook bolts to three-flanged plate drumheads, and to two *intermediate* wrought-iron rings. The plate drumheads are fastened to cast-iron bosses keyed on to the drum-spindle, which revolves in long bearings fixed to a cast-iron bearing-plate bolted to the two vertical frame pieces. The beaters are themselves long screws made by twisting rolled bars. After these are twisted and straightened, grooves are cut in them, at the necessary distances apart, to receive the hook bolts by which they are held on the drum.

The concave B^1 (Fig. 32) is made in two parts connected by a long transverse pin or bolt a little below the sectional length of the concave. It consists of two main end pieces of wrought iron, and a number of intermediate similar shaped ribs, forming a support to the ribs running transverse to the machine, which are seen in section in Fig. 32. These latter ribs are perforated near their upper edges, and receive curved wires generally about $\frac{5}{16}$ in. in diameter.

A coarse strong grating is thus formed, which is adjustable as to distance from the drum at three points, namely, in the upper part, a little below the middle, and at the forward end of the bottom. The long bolts on which the segments rest pass through the outside of the machine and are there held by three sets of adjusting gear, two being below the drum-spindle and one above, and all attached to iron bearing-plates. The lower part of the concave is made somewhat more open than the upper part. The distance at which the concave is set from the drum is always greater at the top than at the centre, and at the bottom or forward part it is least, the actual distance varying with the nature and condition of the grain to be threshed. For wheat, oats, and barley, in average condition and quantity of straw, it is usually set at $\frac{3}{8}$ in. from the drum-*beaters at the bottom*, from $\frac{5}{8}$ to $\frac{3}{4}$ in. at the middle, and about $1\frac{1}{8}$ in. at the top. For very damp or very dry corn it is, however, set wider or closer respectively, as experience dictates. Sight holes at the side of the machine are provided, through which the distance between the bottom and middle of the concave and the drum may be seen while making adjustments, the distance at the top being seen from the drum mouth.

The advantages of the screw or twisted drum-beater are that, besides being a good thresher, it can be turned as wear takes place, and from two to four new faces presented according to the care taken by the attendants. Moreover, as all feeders habitually feed more towards the centre and one end of the drum, rather than uniformly throughout the whole length, the beaters can be changed end for end with advantage. As the drum runs at a very high velocity, it is necessary that it should be most carefully balanced, and that every part should be of good material and firmly connected.

It has been mentioned that the grain, as the corn or crop passes between the drum and concave, is knocked and perhaps to some extent rubbed out of the ear; but it will be seen from the construction of these parts and the fact that the velocity of the periphery of the drum is 6,047 ft., or considerably over a mile per minute, that the rubbing can only be effected by the straw as it is whisked from drum-mouth to shakers.

In leaving the drum and the directing plate, which is curved upwards a short distance from the concave, the straw flies upwards; its fall upon the ends of the shakers is determined by the inclined board B (Fig. 32), which is adjustable as to inclination. The straw is checked from too rapid ascent of the shakers by two *swinging shutters* placed across the whole width of the machine, as shown in Fig. 32. The shakers consist of four sets of reciprocating wood-frames or boxes, the upper parts of which are filled in with small transverse strips of wood, placed at a short distance apart, so as to form a grating. These sections are mounted upon brackets carrying bearings, and worked by two sets of cranks, S S (Fig. 32). The cranks are set at equidistant angles of 90°. Each shaker-box or section thus receives a similar compound motion, by which the straw is thoroughly shaken and carried forward, while the shaking is increased by a deeply-notched longitudinal piece placed along the middle of the top of each shaker-frame.

The board D (Fig. 32), which receives all that is shaken from the straw, and the board D^1, which receives all the grain, &c., which has dropped through the concave, receive their motion from the crank T, which also gives motion to the wood riddle E. These boards and the riddle E are connected, so that their motions are simultaneous. The rod by which they are connected with the crank T is fixed under the board D^1, and is thinned or flattened near the point of its fixture; being thus made flexible it needs no joint. The riddle surface, which is usually constructed of mahogany or walnut, is grooved in the direction of the length of the machine, the grooves being of 1 in. pitch, and the holes of different sizes from $\frac{1}{2}$ in. to $\frac{7}{8}$ in., the smallest sizes are for such grain as wheat and rye. These parts are suspended by hangers U U, which are firmly fixed at either end and consist of thin strips, usually of tough ash. The board F and the other parts of the lower shoe are suspended by similar hangers (Fig. 32). The shoe also receives its motion from crank T, and is connected therewith by a flexible rod as shown in Fig. 32.

When threshing oats the seed-sieve at W is taken out and a blank plate put into its place, but the seed-sieve is left in for threshing wheat and barley. The sieves G and G^1 vary in mesh from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. according to the grain being threshed. The strength of the blast through and past these sieves is regulated by a slide shown near I (Fig. 32). This blast must be regulated with great care, so that all the grain, including the light grain and chobs, may drop within the bar Z, while the chaff from the upper sieve must be carried beyond that bar. The construction of the fan H is sufficiently shown in the section (Fig. 32).

The elevator J consists of a leather belt, provided with a number of tin-plate cups of the transverse section, indicated in Fig. 32; the speed of the belt is made sufficient to elevate the grain from a full crop. The awner K is provided with knives and beaters, which may be used in part and separately, or all together, at the discretion of the attendants of the machine, and according to the character and condition of the grain being dressed.

If the grain is smutty or brittle, it is usually not passed through the awner, but delivered direct to the second dressing shoe L, the sieves in which vary according to the grain to be dressed, being, for instance, of $\frac{1}{2}$ inch, $\frac{1}{4}$ inch, or $\frac{3}{16}$ in. mesh. Some sieves are made of perforated iron or zinc, others are of woven wire, others again are made with parallel wires. For barley, which is difficult to awn, and for wheat to which there is much firmly adhering chaff or white coat, the whole of the beaters are sometimes used in the awner instead of the knives. The awns and chaff thus removed have to be blown from the sieves in the *second dressing* shoe L by the blast from the fan H^1, and the force of this blast must be carefully regulated so that no grain is carried away. The screen o is a rotary wire screen, the wires being adjustable as to pitch to suit the grain to be screened. Near the front road wheels is a board, hinged at the upper part and lowered so as to assume a vertical position when threshing, to prevent a mixture of the chaff with the cavings.

As already stated, almost the whole of these details are subject to modification to meet the requirements of different countries and practices; and the relative dimensions are also subject to large modifications. In Australia, for instance, where the corn is generally cut off by the ear, the shakers are not needed, while all the riddling surfaces and the parts constituting the dressing apparatus must be very large.

Messrs. Ransome and Co. have introduced a straw-bruising apparatus for attaching to their threshing-machine in hot climates, where straw is unfit for the food of live stock until it has been crushed in some way or other. The straw as it comes from the shakers falls upon a roller furnished with knives, which cut it into rather long chaff. This chaff is fed into a concave, where it is crushed by a second roller armed with blunt pegs, and whence it finally issues thoroughly bruised and in a fit condition for food.

Clayton and Shuttleworth's Finishing Threshing-machine, Fig. 34, is fitted with their patent safety feed-board for feeding by hand, but Wilder's patent self-feeding apparatus can be attached to any machine when required. The drawing is for a 4 ft. small machine with cup elevators.

The straw-shakers in this machine are worked by *a single crank shaft,* and are very efficient, as the

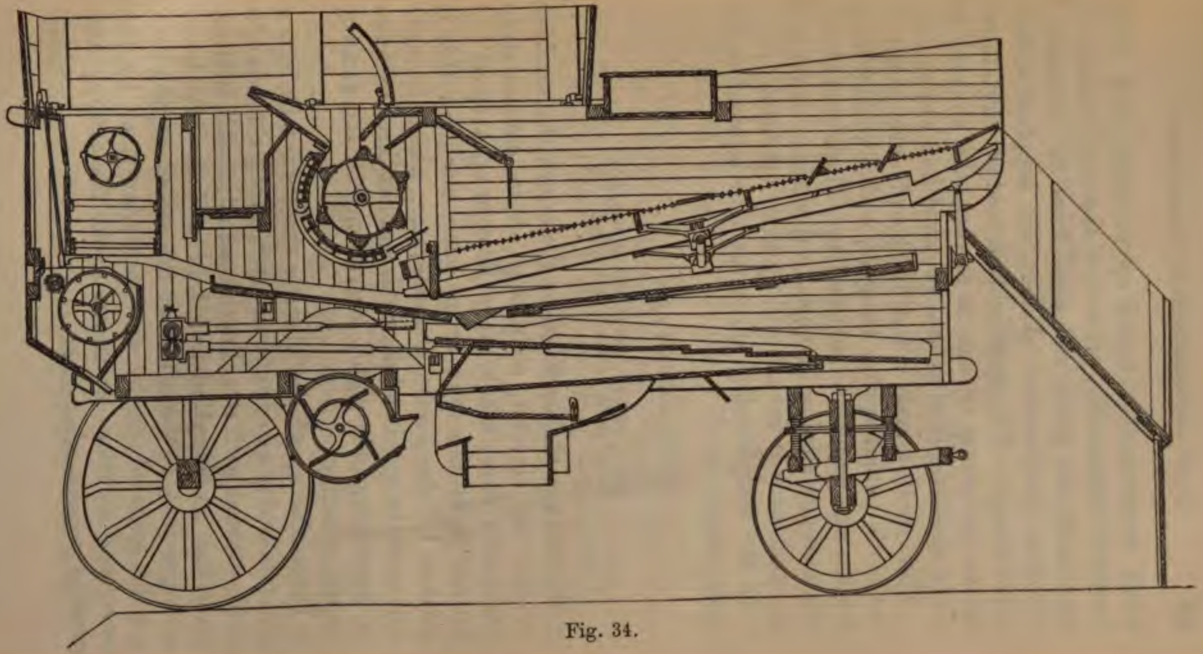


Fig. 34.

straw is alternately tossed up vertically and moved forward horizontally, which is the best motion for separating the grain and chaff from it. If desired, however, double crank shakers are supplied without extra charge. For the neighbourhood of large towns, where the straw is sent to market, the shakers are made to deliver it in as straight condition as possible.

The riddles and vibrating boards are hung on Coulson's patent spring hangers, which work without friction and require no lubrication. These parts being balanced and moving in opposite directions, the rest of the machinery is not affected by their vibration.

In the first dressing apparatus four separations are made, namely :—

Cavings and short straw.
Chaff.
Spoutings, such as sticks, stones, &c.
Small seeds of weeds, sand, &c.

The corn is thence lifted to the top of the machine by the cup elevator, consisting of an endless strap fitted with cups, which carry the corn up a spout and deliver it at the top; or in some machines this is effected by the patent blast elevator, which is made adjustable in speed and diameter and has three varieties of interchangeable plates for rubbing off the awns or beards of barley.

From the top of the elevator the corn falls into a separate barley awner and smutter, which consists of a shaft studded with steel knives and adjustable beaters, revolving in a cylindrical iron casing. It is so arranged that, at the option of the attendant, the corn can be operated on by the awner only, or by the awner and smutter; or it can avoid the awning and *smutting process* altogether.

The corn passes from the elevator or awner just described into a second dressing apparatus, consisting of a series of riddles through which the corn percolates while being acted on by a blast for carrying away the beards, chaff, smut, &c., rubbed off in the awning process. A separate spout conveys the refuse into a sack. Any good corn escaping the riddles, however, is carried back to the first dressing apparatus, so that no waste can take place.

On dropping through the last riddle, the corn enters the patent adjustable rotary screen, by which it is sorted into three qualities.

The machine is capable of threshing all kinds of corn and dressing and finishing it for market at a single operation. It can be arranged, however, to work as a "double blast" by passing the corn direct into sacks instead of through the rotary screen; or as a "single blast" by also removing the riddles from the second dressing apparatus and putting the small blower out of action.

Fig. 35 represents Howard's new patent "trusser," attached to a threshing-machine, by which the threshed straw is caught when leaving the machine, securely tied in bundles with stout twine, and thrown on the ground at the back of the machine, ready to be forked on to a cart or stack. The machine, which occupies very little additional space, is attached to the end of the threshing-machine. As the straw leaves the mill it falls between two revolving canvas aprons, and is carried down to the binding-table in a condition ready for tying. It is delivered in a loose form, but is caught and packed tight by a series of reciprocating points, till the required size of bundle is obtained, when the binding gear is set in operation. A feature of the machine is that it can be set so as to make the bundles various sizes; and as soon as the size that it is set to make is attained and packed, the pressure moves a lever, which brings the binding part of the

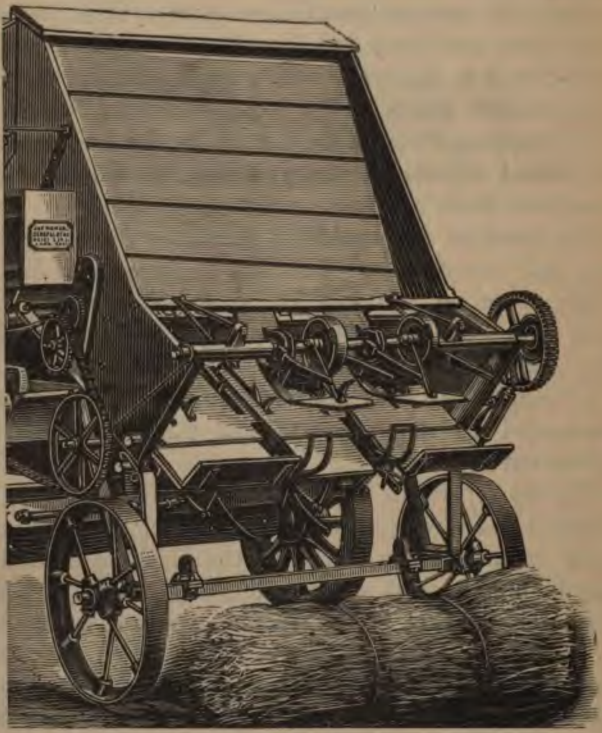


Fig. 35.

machinery into action. The arms or needles that have the string threaded through them are bound round the bundle, across the knotting-hooks, the string is gripped, *and the knotters* perform their work, the knives cross the path of the twine and sever it, and at the same time the levers on which the knives are secured pull off the loop-knots from the knotting-hooks, and eject the bundle to the ground. The needles then fall back to their normal position and await further operations. The whole operation is done instantaneously. Two strings are passed round each bundle at a distance of 15 inches apart, and the bundles are far more shapely, more tightly packed, and more easily handled than bundles made by hand. The machine is said to do the work of six men.

Where it is desired to cut up the straw at the time of threshing, Messrs. Clayton and Shuttleworth supply a large chaff-cutter for attaching to the tail of the machine, and it not only cuts up the straw but sifts and bags the chaff as fast as the straw can be delivered from the thresher. This apparatus will be found more fully described under the head of Chaff-cutters.

In Nalder's Threshing-machine, the shakers, shog-board, and large riddle, are all driven from one crank placed centrally between the shakers, the shaker-boxes themselves being made to act as connecting-rods for driving the shoes. This arrangement dispenses with a great number of bearings, pulleys, and one belt.

Foden's Double-exhaust Finishing Machine was awarded a silver medal by the Royal Agricultural Society, at the York meeting in July, 1883. The principal improvement claimed in this machine is the introduction of an exhaust fan in the place of first and second blast fans, second riddle-box and riddles, and which not only does the work of both, but also acts as a chaff-cleaner and lifter, thus saving the driving power employed on the first and second fans, straps, time in oiling, and cost in repairs, &c. The exhaust fan makes a perfect sample of smut wheat, and will take all the light from any other grain perfectly.

The early threshing-machines were nearly all driven by horse-power, a few by water; now steam power is most generally employed. It seems to be pretty well agreed that, with the present price of horses, it will not do to thresh a large farm by horse-power.

For very small holdings, the "Tiny" threshing-machine, Fig. 36, manufactured by Murray, of Banff, is extensively used. It is made in several sizes, adapted for hand, pony, or horse-power, and will thresh from 10 to 24 bush. of grain per hour. The prices vary, according to size, from £6 10s. to £37, complete.

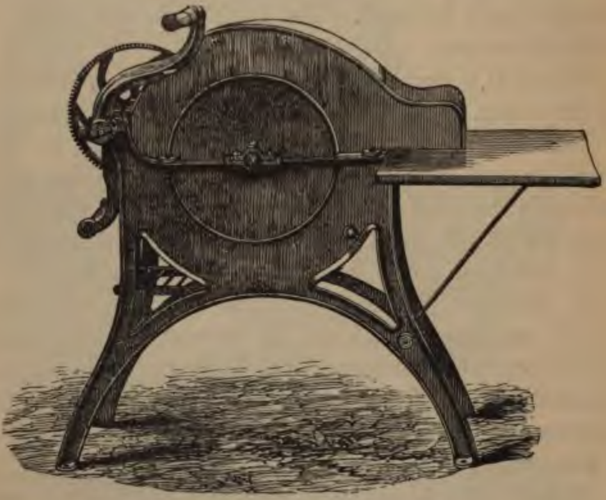


Fig. 36.

A 4-horse threshing-machine will thresh from 20 to 30 bush. of wheat per hour, and from 40 to 50 bush.

of oats or barley, according to the strawiness and yield of the crop.

A steam thresher of 6 to 8 horse-power will thresh from 60 to 80 bush. of wheat per hour; or from 600 to 800 bush. in a day of 10 hours; and of oats or barley a third or even a half more.

The cost of a steam threshing and finishing-machine, say of 6-horse power, is about £135. This price will include a safety drum-guard; but the cost of fitting a self-feeding apparatus would be extra, as would also straw elevator, straw bruiser, or chaff-cutting, sifting, and bagging apparatus.

CHAPTER X.

CORN-DRESSING MACHINES.

WHERE the threshing-machine is a non-finishing one, separate corn-dressers of various kinds for hand-power will be required in order to properly prepare grain and seeds for market. The difference in price between a well-dressed and an ill-dressed sample of corn or seed is so great, that it pays the farmer to obtain the very best machines for this purpose, on even a moderate sized farm.

The most necessary of these machines is the winnowing-machine, for separating the chaff, light corn, small seeds, and dirt, from the good grain. In the ordinary winnower, a fan blast acts in conjunction with riddles, for the cleaning and separation of grain; but in some of the more recent machines, the blast is replaced by an exhaust fan.

The principle upon which the ordinary improved winnowing-machines act is this. A strong current of air is driven by the fan up an inclined tunnel, above which is a hopper, having a sluice gate, through which the corn is allowed to pass in any given quantity on to the riddles and sieves, which are made to oscillate. As the corn passes from the hopper into this shaking riddle, it is at once acted upon by the fan, and the lighter chaff is blown off; the remainder passes through the riddles into the sieves below, through which the good grain passes, while the light corn and the small seeds are blown past the sieve and fall into their proper channels.

Hornsby's Corn-dressing Machine (Fig. 37) presents several improvements on the above. It is fitted with a spiked roller, working through a grating so arranged as to form a hopper, and is easily adjusted to suit corn, either in rough chaff or any other state. It is also fitted with a double shaking screen at the bottom, which more effectually cleans the corn from all kinds of small seeds than a fixed one.

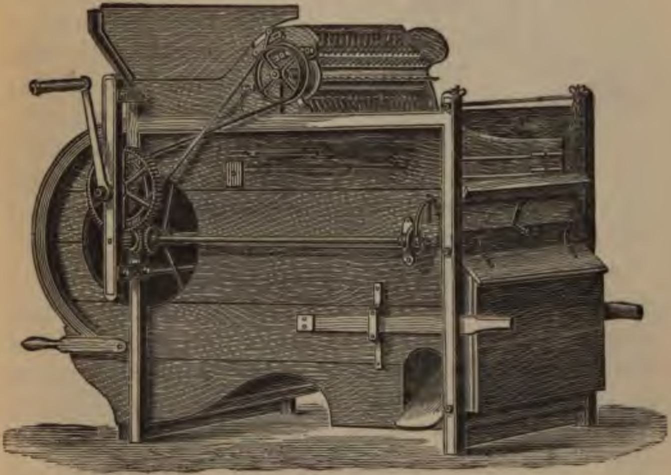


Fig. 37.

These machines are sent out fitted to dress wheat, barley, oats, rye, tares, beans, and peas. They can also be used for blowing dust or smut from the grain, and are readily adapted for dressing seeds.

Boby's celebrated Corn Screens have recently received a further improvement by suspending the screening surface upon wood spring suspenders, thus doing away with the principal and most costly wearing parts, and reducing the power required to turn them to a minimum. Any number of wire beds of different gauges can now be had with the same machine, and so arranged that they can be removed and replaced with the same facility that riddles are changed in a winnowing or dressing-machine. These screens are fitted with blower, as in Fig. 38; or the screen may be had without the blower.

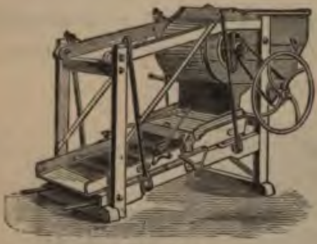


Fig. 38.

At the York meeting, 1883, the Royal Agricultural Society awarded a silver medal to Messrs. Shield and Crockett, for an ingeniously simple corn screen. It is a wire screen, the wire being wound in one long spiral in such a way that the form of the cylinder produced is traversed by one furrow, which extends from end to end. The screen heads are cast iron, with heavy rims projecting considerably beyond the bosses, which fit loosely upon the shaft. They are thus allowed to "wobble" on the shaft, with the result that the wires of the screen are always closer together at the bottom than at the top. No brush or any device is required to clean the screen, as any grain which may fix itself in the lower part of the screen falls again freely within it when that part of the screen in its revolution reaches the top. The screen is thus self-cleansing, and being constructed in a spiral or screw form, the corn, &c., is conveyed out without the aid of any sheet-iron, worm, or other propelling device, so that the whole of the interior is screening surface. The machine is not only simple, but works efficiently in every way.

Fig. 39 shows the screen complete in frame. It represents the screen when closed for dressing seeds, &c., and being of simple construction it is readily opened or closed with the adjusting handle to suit all kinds of grain or seeds.

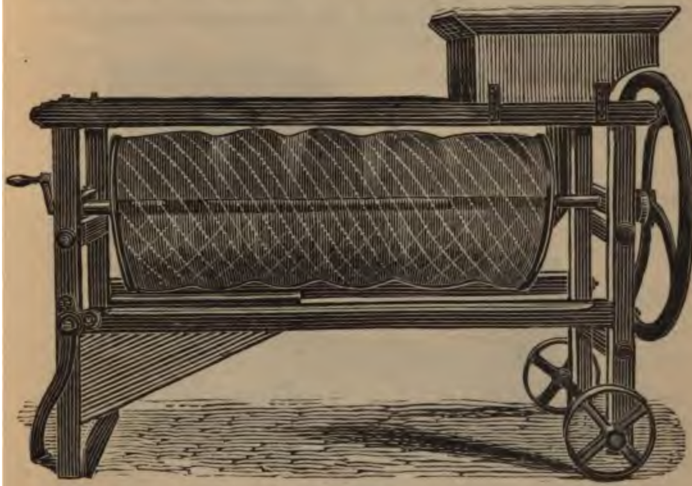


Fig. 39.

Of special seed cleaners and seed-sorting machines for dealing with clover, rye-grass, and other small seeds, there are several; and as a rule they are more efficient for this purpose than the combined machines intended to dress either corn or small seeds.

Boby's Seed-sorting Machine (Fig. 40) aims at, and does to a very great extent improve clover seeds by separating dirt and weeds, as well as plantain and rye-grass; and by changing riddles it will successfully act on goose-grass, hair-grass, &c.

This screen has not the usual sifting motion, but the wire or perforated bed is acted upon by means of a spring hammer, which agitates or imparts a tremulous motion to the bed, and has the effect of making the seeds present every point of surface to the riddle, and gives all possible chances of their passing through.

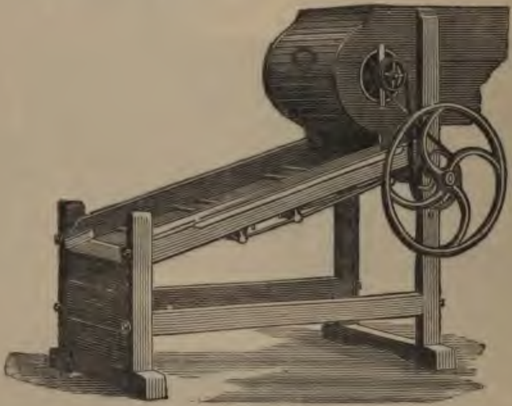


Fig. 40.

Richardson's Seed Cleaner, which was brought into notice at the trial of seed-cleaning machines, held at Edinburgh by the Highland and Agricultural Society in the spring of 1883, is fitted with a set of three or more sieves placed in steps or stairs in the same sloping frame. This frame oscillates lengthways with a heaving sort of motion, by which a heavy-headed seed, such as wire grass, when dropping from one sieve to another, is made to fall on its heavy head, and so pass more readily through the meshes of the sieve. This machine is chiefly intended for rye-grass seeds, and to do the chaffing, riddling, and screening at one operation. By changes of sieves and riddles it may be made to dress other seeds, such as turnip-seeds and clovers; but it appeared to be less successful with the clovers than with the rye-grass seed.

Awners or Hummelling Machines.—These machines are for the purpose of removing the awns from the barley, and are indispensable on a barley-growing farm, if a non-finishing threshing-machine is employed. The old plan of doing this was to put the barley through the threshing-machine a second and third time; but this injured the grain for malting, and was besides a laborious process. The addition of an awner to the threshing-machine, enabling barley to be turned out clean at one operation, as easily as all other grain, was, therefore, a decided step forward.

One form of barley awner is that already described in connection with Clayton and Shuttleworth's threshing-machine. It consists of a shaft studded with knives and adjustable beaters, revolving in a cylindrical casing. This is the class of awner with which most of the modern finishing threshing-machines are fitted; and it is equally suited for the purpose when made separate and worked independent of the thresher.

Boby's Barley Hummeller is illustrated in Fig. 41. The barrel is made of iron, and a strong wrought-iron spindle runs through the centre, on which is fixed a series of knives which revolve at great speed. These knives are so shaped that although the barrel is fixed perfectly straight on the frame (and not inclined like those generally in use, which have a tendency to let the barley escape before it is properly awned) the knives of themselves force the barley along the tube, so that it is impossible for the corn to escape from the spout until it has been subjected to the action of the whole of the knives in the barrel; and by the time the corn reaches the outlet it is effectually deprived of the awns. The machine is very simple, and can easily be worked by one man.

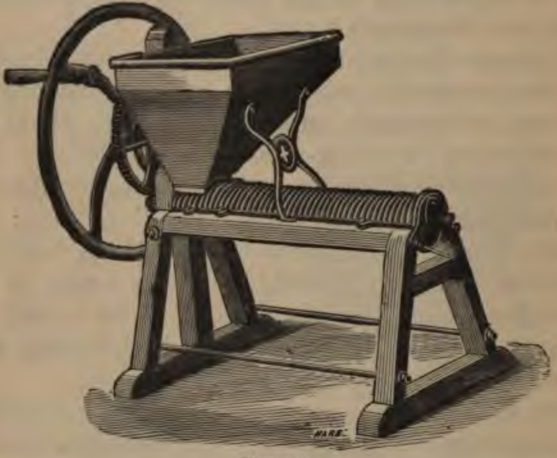


Fig. 41.

The same hummeller is made of a size suitable for being worked by power, and adapted for attaching to any large portable corn-cleaning machine, or for fixing in barley stores. This machine will effectually deprive the kernel of the horn or needle without damage to the grain at the rate of 120 bush. per hour. It is fitted with 9-in. fast and loose pullies, which should be driven at about 250 revolutions per minute.

CHAPTER XI.

BARN UTENSILS AND APPARATUS.

THE usual form of barn shovel is shown in Fig. 42. It is made wholly of wood. The one here illustrated, which is Bobey's manufacture, has the handle worked up separately and secured to the blade by two bolts and wrought socket plates, and by unbolting the handle a flat turning blade can readily be substituted for the deep blade if desired. The blades are 20 in. by 13 in., and made of thin, light, hard wood.

An article which is useful alike in the barn and in the chaff-bin is the hand-sieve (Fig. 43), for sifting dust and small seeds from corn and cut chaff. They are

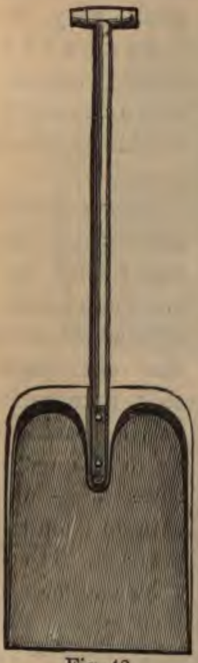


Fig. 42.

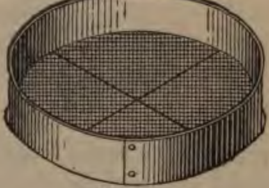


Fig. 43.

now usually constructed with wove wire bottoms, and are made with the wire mesh of various sizes to suit different kinds and qualities of grain.

Boby's Improved Grain-sampler (Fig. 44) ought to be extensively used by farmers and corn merchants. By means of this instrument samples of grain can be drawn with the greatest facility from the middle of a large heap, or from the interior of a cargo, so insuring the purchaser of buying equal to sample. In this way also temperature and condition of large quantities of grain may be frequently tested, without unnecessary trouble or loss of time.

Sack-lifting Barrow. — The sack-lifting apparatus is a valuable addition to the old plain sack barrow, in moving sacks of grain from the threshing-machine or from the granary. It enables one man to remove the sacks from the machine as fast as they are filled, and without the assistance that would otherwise be necessary for getting them on to his back. The illustration shows the positions of the barrow, by Clayton

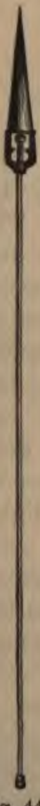


Fig. 44.

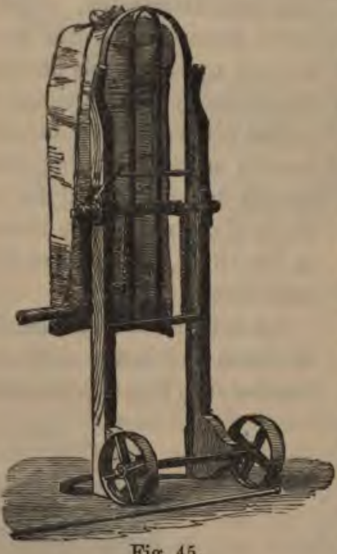


Fig. 45.

and Shuttleworth, with a sack partly raised. These barrows are strong and durable, and by means of a wheel and pinion motion in connection with the raising apparatus, are also very easy to work.

Sack-Holders.—Gilbert's Improved Patent Iron Sack-holder (Fig. 46), manufactured by Richmond and Chandler, is a useful labour-saving invention. It holds the mouth of the sack wide open, forms a rest for the vessel used in filling, saves the expense of an assistant, and is very light, portable, and cheap, costing only £1 3s. At a small extra cost the sack-holder can be had on wheels, which, when the sack is filled, forms a neat and convenient barrow for conveying it where wanted.

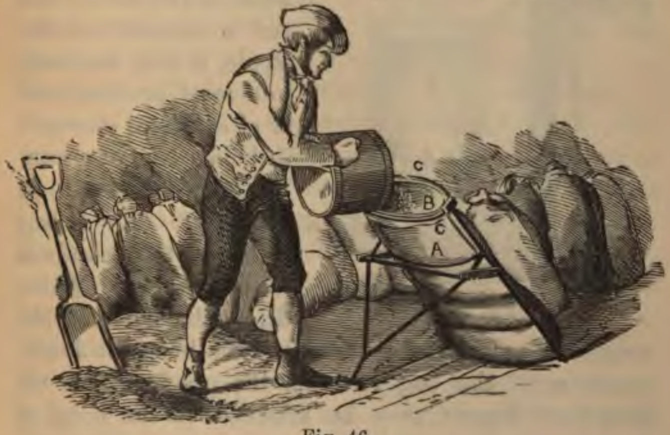


Fig. 46.

An American bag-holder on platform scales is shown in Fig. 47. It consists of an iron hoop, nearly as large round as a corn sack, with several small hooks on it, at equal distances, to which the bag is suspended. Attached to the hoop is an iron rod, with a hook end which slips into a socket on the front of the upright enclosing the rods that run from the platform of the scale to the weighing beam. The shank should fit loosely in the socket, to let the hoop tilt down, so that the bag can be readily unhooked. There is an eye-bolt in the hoop where the iron rod joins it, and a rod with a hook on the upper end is fastened into it. This rod reaches to a staple fastened above the socket on the upright of the scales. When the hook on the end of this rod is slipped into the staple, it lifts the hoop to a level position, and is of sufficient strength to hold a bag of grain. The hoop should be high enough to allow a bag to clear the platform of the scales. When filled, the hook of the sustaining rod is released, and lets the hoop tilt downwards, until the bag rests on the platform. A tin funnel or hopper may be attached to the hoop, if desired, as in the engraving.

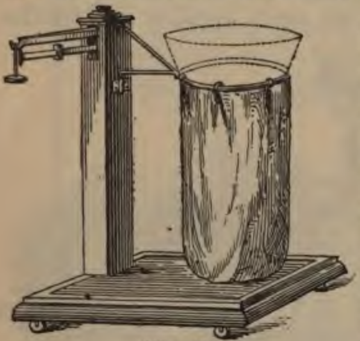


Fig. 47.

Sack-hoisting Machinery.—Presuming farmeries to be constructed in their arrangements something more nearly to mills and manufactories, there will be required an easy method of hoisting sacks and other weights from the lower to the upper floors or granaries. A common crane and windlass is often used, but this is an exceedingly slow process, and not always convenient.

In flour-mills it is necessary to have the means of hoisting with rapidity and ease the sacks of corn from *the lower floors to* the higher, for the purpose of emptying it into the hoppers for supplying the stones; or to raise the meal from the bins on the lower floors to the upper, to be passed through the dressing machine; and for this purpose a machine called a sack-tackle or hoist is used. It is exceedingly simple, and answers the purpose admirably.

Sack-tackles are constructed in several different ways, but the one most in use is as follows:—

In the roof of the building is placed a wooden framework, moving with hinges at one end; across this frame is placed a shaft, or spindle, having upon it a wheel, or pulley, and a barrel to carry the chain or rope; in a line with the pulley in some direction, and upon a shaft always kept running, is placed another pulley; over these two pass a strap, made so loose that the pulley in motion does not give motion to the other. At one end of the sack-tackle frame is a piece of iron, set up with a strong spring to press it forward, and having a projecting notch or ledge on the face of it. We have before observed that one end of the frame was movable; when a sack is required to be hoisted, one end of the wooden frame, and with it the shaft carrying the pulley and chain-barrel, is lifted; the strap then works tight on both the running and the other pulley, and the chain or rope works round the barrel. The frame is lifted by a cord running through a small pulley above, and passing through a hole in each floor beside the sack-traps, through which the sacks are hoisted. When the frame is lifted by this cord, it passes up the face of the iron spring till it arrives at the notch, upon which it rests. The cord by which the frame is lifted is called the striking-in line. As long as the frame remains on the notch, the barrel continues to revolve and wind up the chain. This of course requires another arrangement to again slack the strap and stay the action of the winding barrel; this is effected by simply having a line to draw back, the spring, upon which the frame descends to its former position. This line is carried down through the floors beside the other, and is called the striking-out line. At the lower end of the chain is a ring large enough to admit of the sack being passed through double; a loop is thus formed which takes hold of the neck or tie of the sack; the striking-in line is pulled with a jerk, and the sack ascends to the required height; the striking-out line is then pulled, and the sack drops on to the floor above the traps.

In some sack-hoists the strap is tightened by a lever pressing against it; the frame and barrel then being stationary, nothing taking place but the tightening of the strap by the lever.

In others a hollow cone is used, working on to a solid one, which is always moving; but the ordinary one we have attempted to describe.

Weighing Machines.—It is of course indispensable for every farm to be provided with beam and scales, or other apparatus, for ascertaining the weight of grain, wool, and other commodities, in quantities varying from 1 lb. to 3 cwt. But, besides this, it is very desirable to have a machine by which not only turnips, hay, manures, &c., can be weighed in cartloads, but by which also the live weight of pigs, sheep, and bullocks can be ascertained.

The common steelyard is a lever of the first order, in which the arms are unequal, and the same weight is used to weigh different substances by varying its distance from the fulcrum. To graduate the steelyard, first find the zero subdivision by bringing the unloaded instrument into equilibrium by shifting the weight or counterpoise. Put then on the hook, or in the pan, such a number of even pounds as will push the counterpoise to the greatest distance it can go on its arm for even pounds, and divide the distance between this last position and the zero point into as many equal parts as there are then pounds on the hook. The points of division so obtained are the position of the counterpoise for the several pounds up to that number, and for half and quarter pounds, &c., these divisions must be subdivided.

CHAPTER XII.

FOOD-PREPARING MACHINES.

THIS division of our subject embraces a large assortment of machines, including as it does turnip-cutters and pulpers, root-washers, oil-cake breakers, corn-bruisers, grinding-mills, chaff-cutters, and steaming apparatus. No very striking improvements have been introduced amongst any of them lately.

Turnip-Cutters and Slicers.—Machines of this class are now largely superseded by the more approved root-pulpers, especially where the roots are to be fed mixed with chaff or corn. For sheep feeding in the turnip-field, however, the turnip-cutter is still, and will probably long continue to be, extensively used.

Two different forms of turnip-cutters are chiefly in use at the present time—the barrel and the disc forms.

Of the former class, Gardner's machine in its improved form is the best. Fig. 48 represents a section through the barrel and hopper of a Gardner machine, showing the cutting principle. Cylinder turnip-cutters were in use long before Gardner patented his machine, but they only cut large and very unequal slices. The knife in them was extended entirely across the cylinder with an unbroken edge, and had the cross knives placed under the slicing knife, of which there were two, and raised above the cylinder the thickness of the slice cut.

Gardner's improvement consisted in the arrangement of the face of the cutting-knife into sections of a width equal to the required cut of the root—each knife

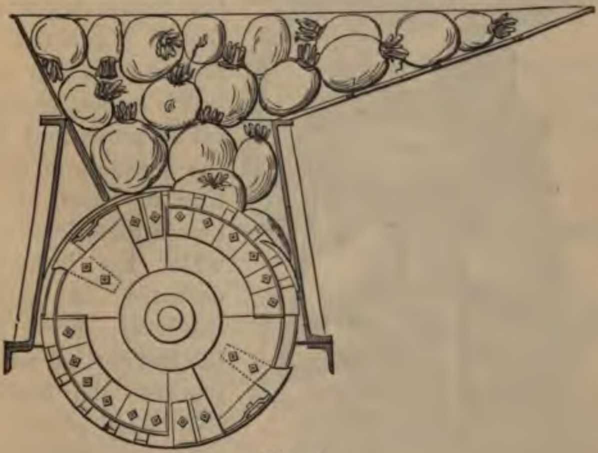


Fig. 48.

cutting on the front and side edge at right angles with it, and placed one above another till they meet in the centre, the angles of the knife retiring *en echelon* from the front to the centre. Two of these knives are placed on the cylinder in the cut, and against the front plate is shown a ledge which causes the last piece of the turnip to be cut instead of falling through unslit. This cutting of the last slice has, however, never been fully effected in any but the very latest and most improved machines. In Samuelson and Co.'s Improved Gardner Turnip-cutter, of which Fig. 49 presents a general view, this object is skilfully accomplished by a perforated guard or shield fixed underneath the barrel or cylinder, which prevents any piece that may escape uncut from the front cutting-plate from falling into the basket with the cut roots, and carries it round to the hopper again to be forced through the knives by other roots. The action is perfect, and the result is a great practical improvement in the economy of cutting up roots, as it avoids a certain waste which has hitherto occurred in most machines, owing to the last portion passing into the basket—a large piece, or nearly all, rind, and which is in consequence refused by the sheep and wasted.

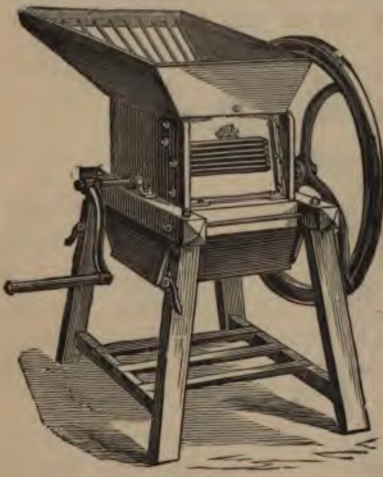


Fig. 49.

The Gardner machine is made with single-action cutters, or with double-action cutters, as wanted to cut either for sheep or for cattle, or with reversible motion to cut for both sheep and cattle. For cattle the machines are fitted with slicing knives only, cutting $\frac{5}{8}$ of an inch thick, and the whole width of the turnip. For sheep, the machines are fitted with knives cutting finger pieces, each $\frac{3}{4}$ of an inch wide and $\frac{5}{8}$ of an inch thick.

All other roots, as mangolds, carrots, &c., may be cut with it equally well,

It is a great convenience to have the machine mounted on wheels and fitted with large drop handles, so that a boy can move it unassisted in the field.

In the turnip-cutters on the disc principle, a series of knives are placed in the face of an iron disc by screws. The turnips are placed in a hopper set at an angle, so that they may press by their own weight against the disc.

Fig. 50 is an illustration of Hornsby's Turnip-cutter on the disc principle. It will cut as rapidly and with even a less expenditure of power than the Gardner pattern cutters, with less weight to move from place to place. By a novel arrangement of the knives upon the disc a great saving of power is obtained, together with unequalled regularity and uniformity in the slices. Each knife cuts a regular and full-sized piece parallel from end to end. Slicing knives for cutting slices for cattle feeding can be added. It has a large wrought-iron hopper, self-feeding, and screening the roots from dirt before passing them to the knives. It is fitted with convenient drop handles for carrying, or may be had mounted on wheels.

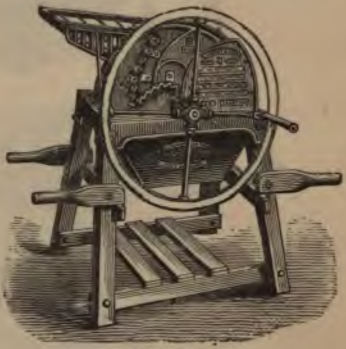


Fig. 50.

The Lever Ball Turnip-slicer (Fig. 51) is still much used in Scotland. It cuts the roots in large broad slices, and is only adapted for cattle feeding. There is but little economy, however, in feeding roots so cut. Experience is every day more in favour of pulping the roots for cattle and mixing with dry food.

Root-Pulpers.—For house feeding, of sheep as well as cattle, the pulper is destined to entirely supersede the turnip-cutter, in districts where it has not done so already.

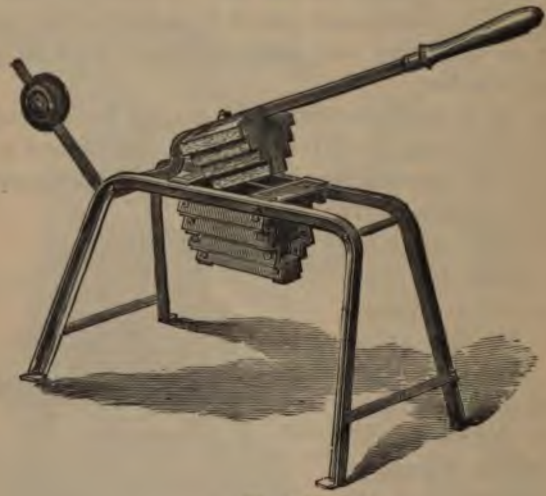


Fig. 51.

Pulpers are made both on the disc principle and on the barrel principle. The former, however, are by far the most extensively used, and very excellent machines of this class are now produced by many makers.

Fig. 52 represents one of Richmond & Chandler's new Disc Root-pulpers, with the side plate removed, showing the arrangement of the knives or cutting points upon the disc. The knives are adjustable to pulp coarse or fine as required; and the shape of the hopper and the positions of the knives are such as to insure perfect feeding and a regular sample of pulp.

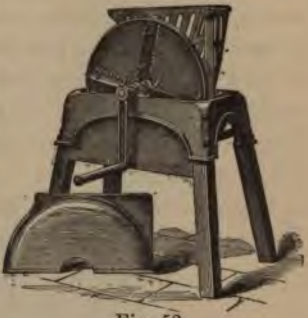


Fig. 52.

The pulpers to be worked by hand are usually fitted with four knives, as in the illustration, each knife consisting of upwards of twenty cutting points. The machines intended to be worked by power are fitted with six or more knives, and have upwards of a hundred cutting points.

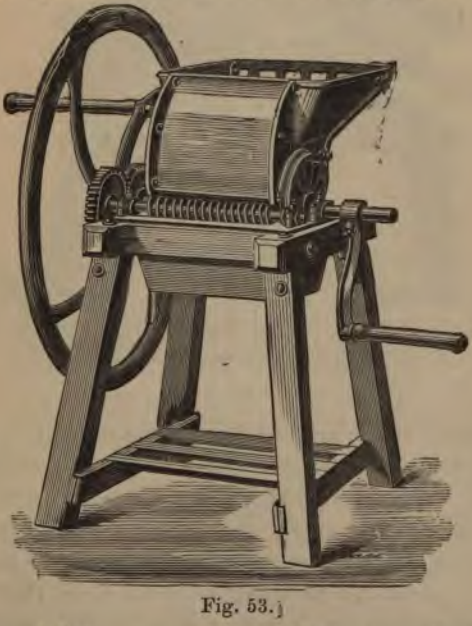


Fig. 53.

A Barrel Pulper, one of Bentall's improved machines, is shown in Fig. 53. This is a large machine for horse, steam, or water-power, and is capable of pulping from 4 to 5 tons of roots per hour. The knives, which are of the best steel, are fastened by means of a wooden wedge, and can easily be replaced in case of breakage. This description of machine is extensively used for pulping cabbages.

Combined Pulper and Slicer.—An exceedingly useful machine of this class has been brought out by Vipan and Headley. A general view of it is presented in Fig. 54. The combined machine consists of two discs with reversible hopper, and can be used either for pulping or slicing as required. The price of the combined machine is very little more than that of an ordinary pulper or slicer, so that in this respect it offers considerable advantage.

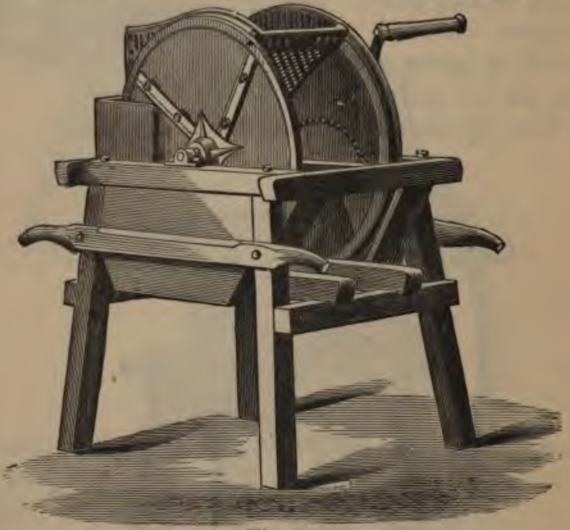


Fig. 54.

Root-Washers.—On root-growing farms a machine of this kind is very needful at times for dealing with roots when covered with dirt. It makes the roots more palatable to the stock, and it effects a considerable saving in time compared with washing the roots without the aid of a machine.

An ordinary practice is to put the roots into a large tub of water, and with a stick stir them about. The roots of course may be thoroughly washed in this way, but they seldom are. There is no excuse for doing the thing badly and in wasting time over it besides, when such capital machines as those constructed by Richmond & Chandler and by Crosskill are to be got at moderate prices.

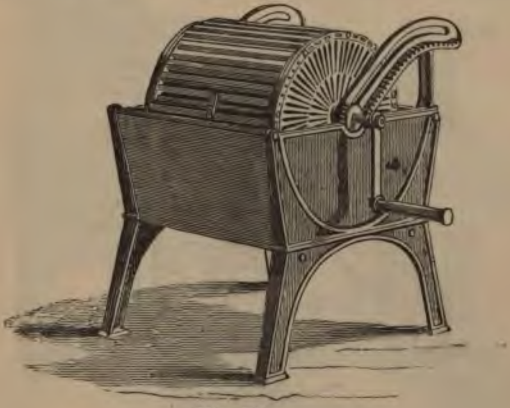


Fig. 55.

Richmond & Chandler's Root-washer (Fig. 55) consists of a trough, within which is a cylindrical cage, supported in bearings fitted to the sides of the trough, from which rises a curved rack. The spindle of the cylindrical cage is fitted with a pinion corresponding to the rack. The object of this arrangement is to raise out and readily discharge the vegetables when sufficiently washed. The price is 4 to 5 guineas.

Crosskill's Archimedean Root-washer (Fig. 56) consists of an open cylinder, partly immersed in water and containing an archimedean screw. The potatoes, roots, or other vegetables, are put in by a hopper, and as long as the cylinder is turned in one direction, they remain in it and are well cleaned, but when the handle is reversed the archimedean screw brings them out of the cylinder, without the necessity of lifting it out of the water as in the other machine.

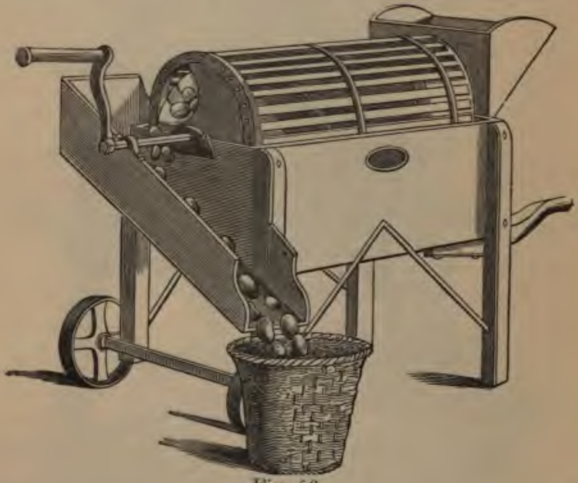


Fig. 56.

The two legs at one end of this machine are placed upon wheels, and at the other end are two barrow-handles, which enable it to be wheeled from place to place with great ease. The price varies from £6 to £8, *according to* the size of the machine.

Potato-Separator.—This is a machine used for the purpose of screening or separating potatoes into sizes ready for sale. It is an exceedingly useful machine on farms where potatoes are largely grown, as sorting them properly insures the farmer a greater profit than selling them mixed large and small. When this sorting is not done by the grower, it is done by the potato dealer, who of course reaps the additional profit thus neglected by the farmer.

Potato-separators have usually been constructed with three sieves or screens of different sized meshes, placed one under another, with a shoot to carry the potatoes from each screen to a separate receptacle, as in Fig. 57. The screen also entirely frees the potatoes from all dirt, straw, or other rubbish. This machine is made by the East Yorkshire Cart and Waggon Company, Limited, who also supply other kinds of potato-separators and washers.

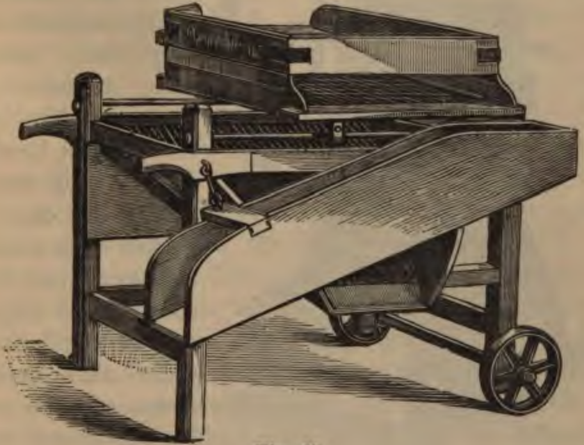


Fig. 57.

Oil-Cake Breakers.—The principle of all these machines is that of two rollers, armed with knobs or teeth, which can be set to any required distance from each other. They will break oil-cake to any size suitable for sheep or cattle.

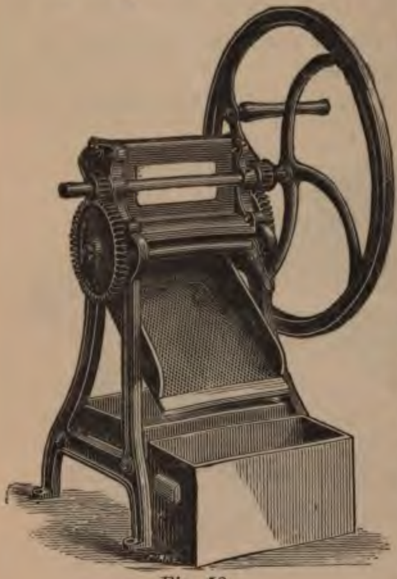


Fig. 58.

Fig. 58 presents a view of Samuelson and Co's., Improved Oil-Cake Breaker. It is provided with a heavy fly-wheel of large diameter, enabling it to be worked with very little power. The rollers are readily shifted by the aid of a handle, and by this means the cake can be broken into various sizes as desired. One side of the hopper can be set back in order that broken pieces of cake may be fed into it with a shovel or by any other convenient method. The dust sifts through into a tray under the machine, whilst another box receives the broken cake. Both of these boxes are provided with each machine. The cost complete, is £3 3s.

Corn-Crushers and Grinding-Mills.—Bruised corn is well known to be more nutritious, and consequently more economical, than grain fed in its natural state.

Oats will go one-half further in measure after being ll crushed, while the horse is put into better condi-n for work at less expense. If fed uncrushed, oats e swallowed without mastication, as is obvious from eir being voided in a whole state, and consequently f little or no benefit to the animal.

The most conclusive experiment on this subject s that which was performed by the London Omnibus Company, who are the owners of 6,000 horses, the one-half of which were confined to one kind of feeding, namely, that of bruised oats, cut hay and straw, and the other half to whole oats and hay. The ration allowed per day to each horse, according to the one system was—bruised oats 16 lbs., cut hay 7½ lbs., cut straw 2½ lbs. The quantity allowed according to the old system was—unbruised oats 19 lbs., uncut hay 13 lbs. There is thus a saving of 6 lbs. on the feeding of each horse, and this saving is not merely in the quantity, but in the value of the articles employed, for we have straw in the former case substituted for hay in the latter. The money advantage in favour of bruised oats and cut hay is fully 2½d. per day for each horse, which is equal to £62 10s. per day for the 6,000 horses. And this saving was accomplished without any sacrifice whatever, for all the drivers and those having charge of the horses agreed that the difference in the condition of the horses was decidedly in favour of those fed on bruised oats and cut hay and straw.

For horses, fatting beasts and pigs, crushed corn is as efficient as fine meal, while the saving in the cost of preparation is manifest.

Kibbling mills intended to break the corn only and to make as little flour as possible, are, therefore, in most demand for crushing corn that is to be fed to stock.

Very excellent machines of this class are supplied by Richmond and Chandler, Marshall, Garrett, Ransomes, Bentall, and other makers.

A cheap and efficient double-action Kibbler by Richmond and Chandler is shown in Fig. 59. The barrel, which is of steel, has two cutting edges; and a cutting plate of hard metal is fitted on each side of the same, so that when turned in one direction it will kibble beans, peas, and maize; and when turned in the opposite direction, it will kibble barley and oats. The machine is made in larger sizes for horse, water, or steam-power. It is also made with a single-action steel barrel; in which case it is provided with two cutting plates of hard metal, one for beans and maize, and the other for oats; and the hopper is hinged, so that when the plates require changing it can easily be turned back.

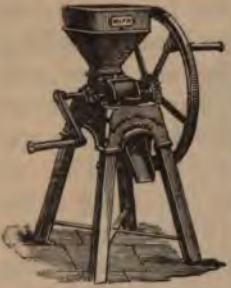


Fig. 59.

Grinding-mills are less useful on the farm, but where steam-power is employed one of these mills is an acquisition, for the farmer can then grind flour for domestic use, as well as grind his corn into meal for his cattle and pigs.

Nothing has yet been invented which will grind corn so well as millstones, or that will so thoroughly meal it and prepare it for cattle food. English grey stones are suitable for grinding barley, crushing oats, or kibbling maize and beans; but for producing fine wheaten flour, French burr stones are necessary.

One of Ransome's grinding-mills is shown in Fig. 60. It is fitted with a bean-cutter, to crack

ans, peas, maize, &c., to a small size before grind-
g.

The quantity of corn ground by this machine in a iven time will ary according o the required ineness of the lour. With a pair of 48-in. stones, 8 to 12 bushels of barley per hour may be ground to fine meal; if only required to be kibbled or partially broken a much greater quantity may be done.

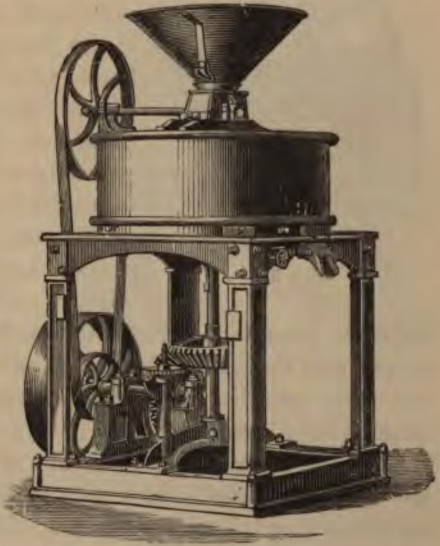


Fig. 60.

Chaff-Cutters.—It is unnecessary to say much about the many and great advantages to be derived from the use of the chaff-cutter. The results of feeding with cut fodder are so visible that no stable or feeding shed should be without one, however few the animals to be fed.

In all the improved chaff-cutters the knives are attached to the radial arms of the fly-wheel, and the uncut fodder is brought up to the knives by a very effective feeding apparatus, consisting of toothed rollers working into each other in such a manner as to insure a regular feed, and prevent all choking.

Fig. 61 represents one of Richmond and Chandler's machines, which are made in sizes adapted either for hand, horse, or steam-power.

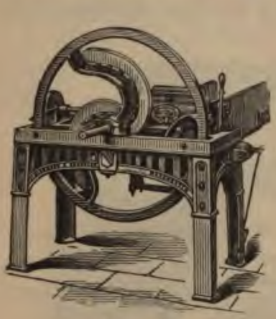


Fig. 61.

The mouth-piece is adjustable, and can be opened or closed (by means of a simple hand-screw on the top) to suit the different kinds of material to be cut. This arrangement not only renders choking an impossibility, but insures a regular sample of chaff.

The hopper can be fitted with a self-acting endless web, an advantage when the machine is worked by power and short material has to be cut; but the great assistance afforded by it is more marked in the larger sizes of machines.

The old lever and weight are abolished and spiral springs substituted, which give an increasing pressure on the feed as it becomes thicker. This is not the case with the weight or lever.

This machine cuts two lengths without change of wheels by merely moving a handle. It can be fitted to cut any two lengths of chaff, from $\frac{1}{8}$ of an inch upwards. The long length will always be just double the short.

The same handle which alters the length of cut also acts as a stop motion, instantaneously arresting the progress of the rollers. To reverse the motion or draw the feed quite back into the hopper the attendant has only to pull round the wheel at the end of the machine, which can be done while the fly-wheel is *running* at full speed.

In Crowley and Co's. Chaff-cutter, Fig. 62 (Samuel Edward's patent) the whole of the working arrangements, namely, stopping, reversing the rollers or feed, and varying the length of the cut, are under the control of one starting lever. A travelling web or feeding apparatus is fitted, when required, inside the hopper of each machine, the action of which web is also under the control of the one lever. This safety appliance offers perfect security to the man feeding. In case of his having both hands caught in the feed, his body would be drawn against the lever in question, which would instantly stop the machine. A further push with the shoulder against the same lever reverses the feed and frees the man. The largest size of this machine has a heavy fly-wheel, upon which are fitted three knives. This machine, running at 200 revolutions per minute, will cut upwards of 4 tons of $\frac{3}{8}$-in. chaff per hour.

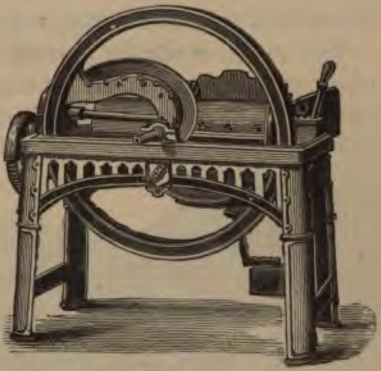


Fig. 62.

Any of the larger chaff-cutting machines are suitable for cutting up grass or other green stuff to be made into ensilage.

The special Ensilage-cutter (Fig. 63) manufactured by Bust, of Winterton, is better adapted for such work. It is a large machine fitted with five knives, and a roomy feed-board, and is specially adapted for being driven direct from the fly-wheel of a portable engine.

If placed near to the silo, waggons can be driven up alongside, and the loads thrown direct on to the cutter feed-board, when it will reduce the product treated to chaff at a tremendous rate, and also throw it into the silo as it is cut, thus saving a great amount of labour.

This machine can be provided with sifting and bagging apparatus, and may be used in connection with a steam threshing-machine, driven from a pulley on the drum-shaft, when the straw, falling from the machine shakers on to the cutter feed-board, is reduced to short chaff, has the dust blown from it, and is delivered into bags as fast as it is threshed. A chaff-elevator, and a salt-sprinkler can also be appended to the cutter, when it is desired to deliver the chaff direct into the top doors of barns or chaff-houses, and to stow it away for future use.

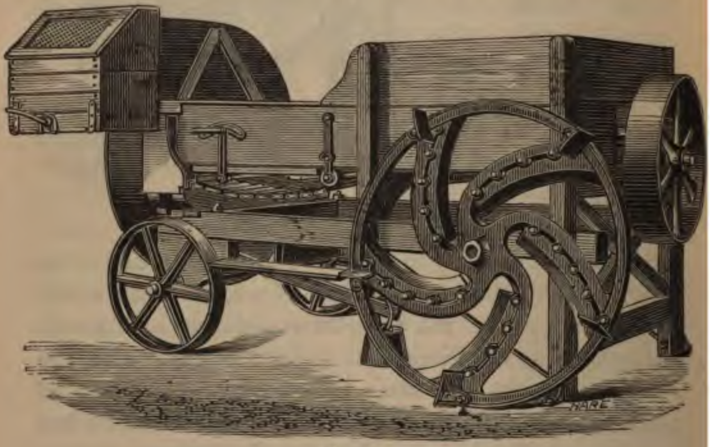


Fig. 63.

Clayton and Shuttleworth's Combined Chaff-cutter, Sifter, and Bagging-machine, for working in conjunction with their threshing-machine, has already been alluded to. The machine is illustrated in Fig. 64. It is one of the greatest savers of labour on a large farm, and is capable of cutting the straw as fast as it is threshed: it not only cuts the chaff, but sifts it, and delivers it into bags ready for removal. It does all this, too, with fewer hands than would be required to stack the straw as it comes from the thresher, even with the help of a straw-elevator.

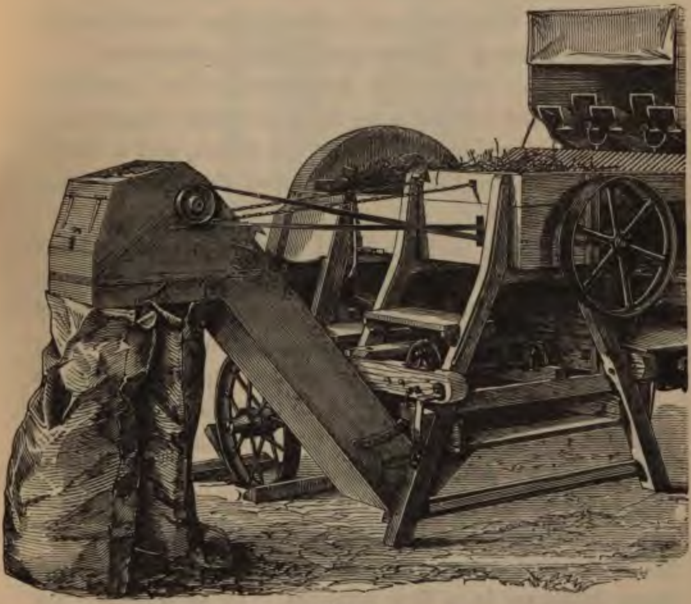


Fig. 64.

Three lengths of chaff can be cut at pleasure by simply changing the gear wheels which drive the feed rollers; these lengths are $\frac{3}{16}$ in., $\frac{3}{8}$ in., and $\frac{5}{8}$ in.; or litter may be cut in lengths of say 1 in. to 3¾ in. by removing all the knives, except one, from the fly-wheel.

This machine is equally well adapted as an ensilage-cutter, in which case it is driven direct from the fly-wheel of a portable engine, instead of by a pulley placed on the drum-spindle of the threshing-machine, when it is used in connection with the latter.

Maynard, Crowley, and others, also manufacture combined cutting, sifting, and bagging-machines.

Steam Food-Preparing Apparatus.—The ordinary apparatus used for steaming food for stock consists of a copper or boiler for generating the steam, and a receptacle into which the food is placed to be acted upon by the steam.

In homesteads where a fixed engine is employed for threshing and other purposes, it will probably be convenient to make the same boiler supply the coppers for cooking the food. In other cases, a complete steaming apparatus to suit the size of the holding may be arranged separately. Several of these are now manufactured by different houses, properly constructed for the purpose. Among these, Barford and Perkins' apparatus is to be reckoned one of the best, simplest, and most economical. Being self-contained, it requires no brick-work whatever, and can be easily fixed by a farm labourer in a few minutes. It is adapted for steaming hay, chaff, roots, corn, linseed-meal, and other compounds, and for boiling milk and water for pigs, horses, and cattle.

Fig. 65 represents a set of this apparatus, capable of steaming all the food for about twenty-four cattle and as many pigs, at a cost in fuel of less than one shilling per day. Thousands of tons of potatoes have been steamed by it at a cost of fuel not exceeding one farthing per cwt. It consists, as will be seen, of a wrought-iron steam generator and two 6-bushel revolving root or chaff pans. Where much hot water or milk is wanted, a 60-gallon strong galvanised-iron compound or boiling pan can be substituted for one of the revolving root or chaff pans. The price, complete with two pans, is £23.

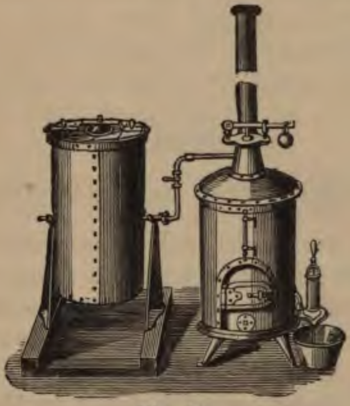


Fig. 65.

CHAPTER XIII.

ARRANGEMENT OF BARN MACHINERY.

Fixed barn works, although a comparatively recent invention, are already becoming a thing of the past. The ponderous fixtures found in many barns, especially in the northern parts of the kingdom, are now judged unnecessary, both on account of their expense, and because they absorb too much power for the amount of work they perform.

As an illustration of how farm customs change, the judges' report on Derby Prize-farm Competition in 1881 mentions that the fixed threshing-machine which the tenant of the first-prize farm put up less than twenty years ago is now seldom used. It is found cheaper to hire a portable engine and machine, and thresh the stacks where they stand, rather than remove them to the barn, although the rick-yard adjoins it. Upon the second-prize farm is a capital fixed chaff-cutter, but it is considered more economical to cut up the straw at the same time that it is threshed in the field, and to remove the chaff in large bags direct to the buildings, where it is safely stored until it is wanted for the cattle.

Beyond the question of convenience, the great expense of putting in a fixed engine and threshing-machine has made it a matter that few farmers cared to undertake, seeing that the landowners in many cases would not take them off their hands at valuation, and the loss by removal being so considerable.

Besides, in nearly every case the arrangement of fixed barn machinery has had to be made to suit an existing building, and cannot, therefore, be said to be the best, or so complete as it might be if the building were made to suit the machinery.

For these reasons farmers are now very generally in favour of portable engines and movable, or at least only semi-fixed, machines.

As an example of fixed barn machinery, however, we give in Figs. 66 to 68 an arrangement planned by Messrs. Clayton and Shuttleworth, and which plan they have followed in various erections.

The plan shows the machinery worked by a steam-engine, but of course the same arrangement can be carried out with water-power where such is available.

Mode of Transmitting Power.—In the early threshing-machine, the power was transmitted through gear, that is, through a train of toothed wheels. In the modern machine the power is taken direct from the fly-wheel of the engine to the drum, upon the axle of which is a metal sheave: all the other parts of the machine are also driven by belts, so that when it works, noise is reduced to a minimum.

In some winnowing-machines also there is no gearing, the motion being communicated to the fan, riddles, and screen by means of cords and bands working round pulleys, and driven from cranked fan-shaft.

And where a steam-engine is employed, although any single machine is perhaps best driven direct from the fly-wheel, to make a complete and convenient barn it should be fitted up with an intermediate shaft and

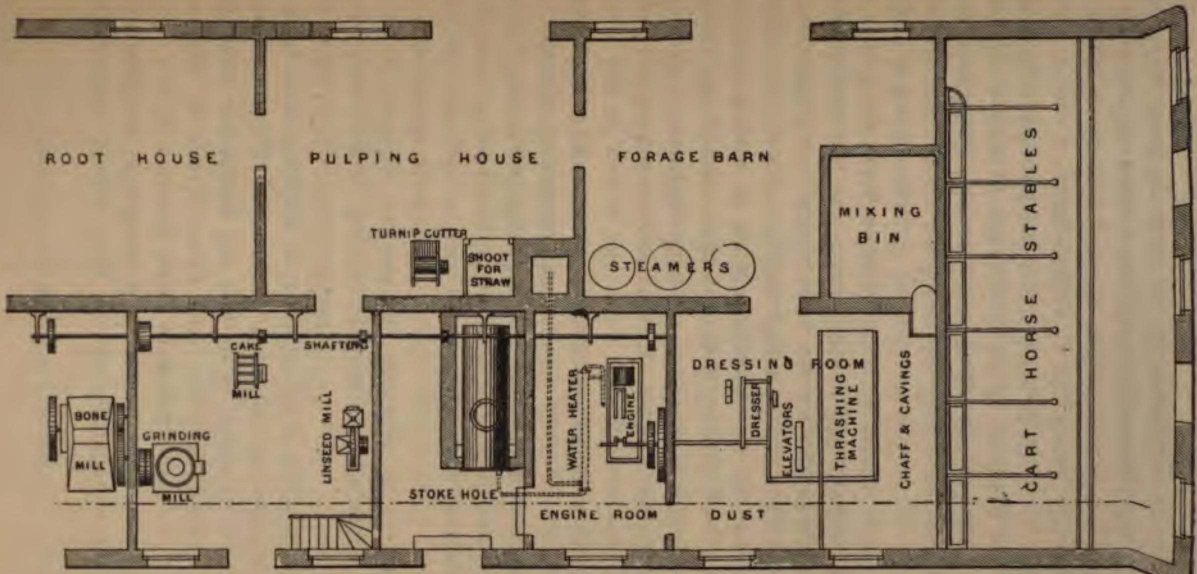
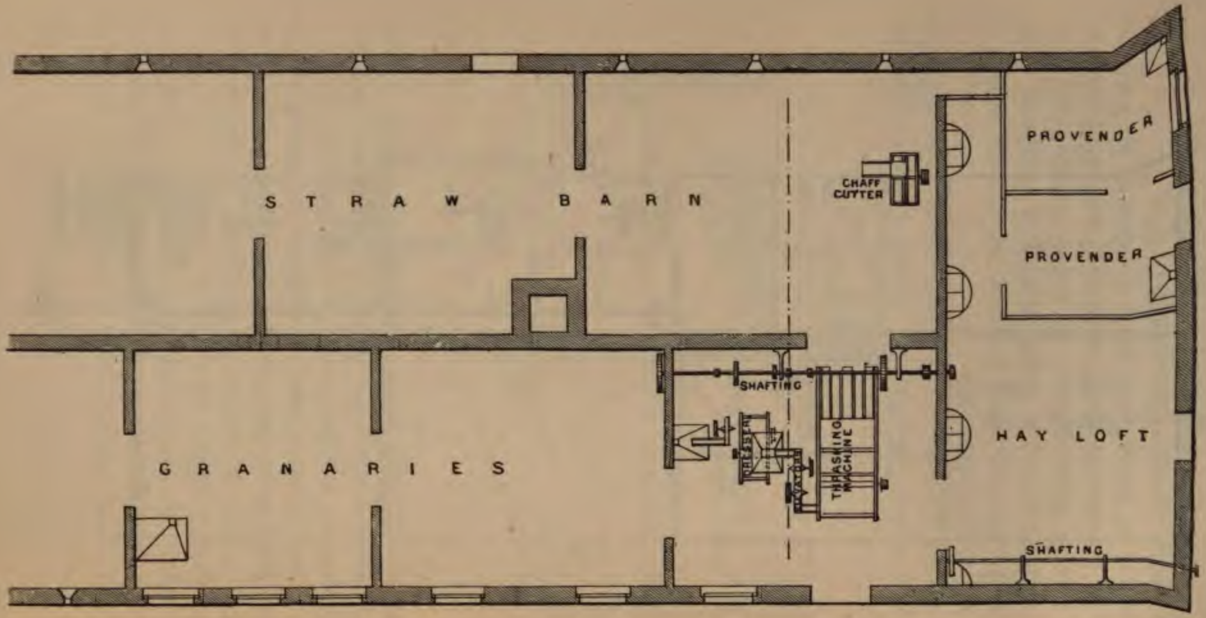

ROOT HOUSE
PULPING HOUSE
FORAGE BARN
TURNIP CUTTER
SHOOT FOR STRAW
STEAMERS
MIXING BIN
CART HORSE STABLES
CAKE MILL
SHAFTING
BONE MILL
GRINDING MILL
LINSEED MILL
STOKE HOLE
WATER HEATER
ENGINE
ENGINE ROOM
DUST
DRESSING ROOM
DRESSER
ELEVATORS
THRASHING MACHINE
CHAFF & CAVINGS

Fig. 66.


STRAW BARN
CHAFF CUTTER
PROVENDER
PROVENDER
SHAFTING
DRESSER
ELEVATOR
THRASHING MACHINE
HAY LOFT
GRANARIES
SHAFTING

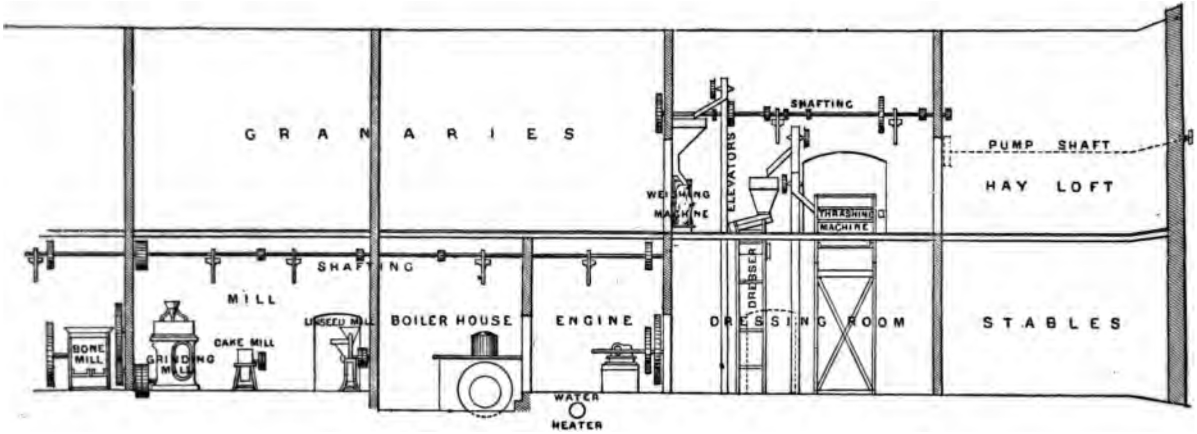

GRANARIES
SHAFTING
WEIGHING MACHINE
ELEVATORS
PUMP SHAFT
HAY LOFT
THRASHING MACHINE
SHAFTING
MILL
BONE MILL
GRINDING MILL
CAKE MILL
LINSEED MILL
BOILER HOUSE
ENGINE
DRESSER
DRESSING ROOM
STABLES
WATER HEATER

Fig. 67.

pulleys, from which may be driven not only the threshing-machine, but all classes of food-preparing machines, the circular saw, the bone-mill, or any other machinery requisite for the farm.

The line shaft may be carried either by pedestals, or in hangers, or on wall-brackets, as is most convenient. There are several lines of shafting employed in the arrangement of machinery shown in Fig. 67.

Horse or cattle gears furnish a convenient arrangement for driving small machines by animal power. This is shown in Fig. 69, where a horse gear by Turner, of Ipswich, is arranged to work three different machines simultaneously.

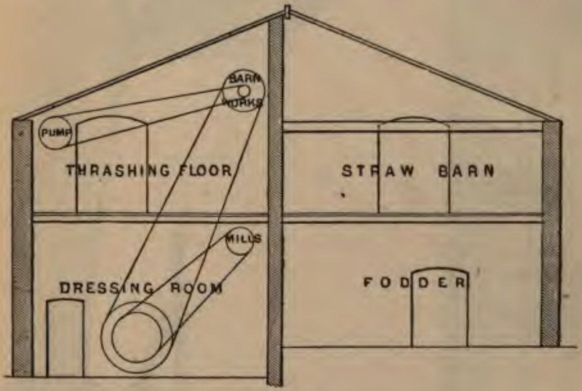


Fig. 68.

As already remarked, it is now out of the question to think of threshing a large or even a moderate sized farm, with horse-power. On small occupations, however, a 1-horse threshing-machine is sometimes worked by means of horse gear, as is the case of B. Reid and *Co's. small* thresher, illustrated in Fig. 70.

Cost of Barn Machinery.—The following is an appoximate estimate for steam-engines and threshing-machines, &c., for farms of about—

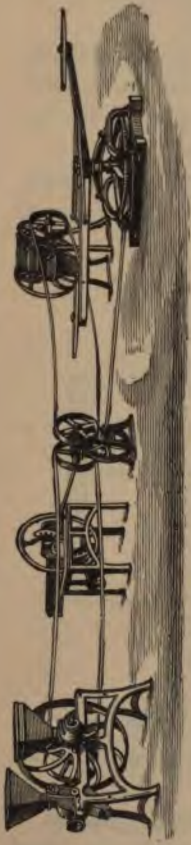


Fig. 69.

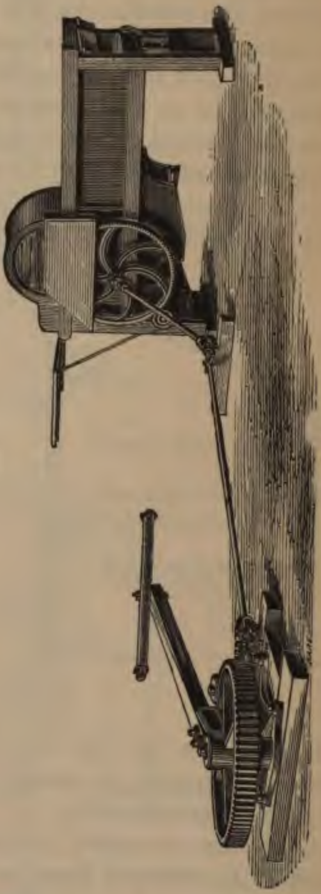


Fig. 70.

	100 Acres.			200 Acres.			300 Acres.		
	£	s.	d.	£	s.	d.	£	s.	d.
Engine and boiler complete	71	0	0	85	0	0	105	0	0
Threshing - machine and fan	42	10	0	55	0	0	100	0	0
	116	10	0	147	0	0	208	0	0
Corn-bruiser	5	5	0	7	7	0	10	10	0
Chaff-cutter	6	0	0	8	0	0	10	0	0
Turnip - pulper and slicer	5	5	0	6	10	0	7	15	0
Grinding-mill . . .	16	16	0	16	16	0	16	16	0
Litter-cutter . . .		—			—		6	5	0
Circular saw, spindle, and bench . . .		—			—		15	0	0

CHAPTER XIV.

STACK COOLERS AND GRAIN DRYERS.

The Neilson system of harvesting in the stack is an indispensable help to the making of good hay, and enabling the crop to be secured earlier than is possible without the exhaust-fan. No grain, also, should be stacked without making arrangements for operating upon the stacks with the fan, as, however well corn or hay is secured, heating to a greater or less extent always takes place, and by applying the fan the heated air can be withdrawn from the rick, which will improve the colour and aroma of the produce and make it more marketable.

In wet and late seasons, when there is little or no sunshine, the harvest fan will be found invaluable in enabling the curing of hay and corn crops to be completed in the ricks, when otherwise the produce must be completely spoilt, or greatly reduced in feeding value, by prolonged exposure to rain and weather.

This method of curing crops is based on the fact that air only is needed to dry the corn or hay after it is harvested, the sun having already done its work. All that remains to be done is to control the fermentation which takes place in all ricks, even when grass or corn is put together in neither a very green or damp state.

The stack is built with an air-hole or shaft in the centre, and pipes are laid to connect this shaft with a suction-fan or exhauster. When the fan is set going it speedily draws off the hot air and moisture from the central shaft, and as this creates a partial vacuum the external air is drawn in at all points of the rick, thus thoroughly drying the grass or corn however wet its condition may have been to begin with.

Fans of various descriptions are now employed for this purpose, most of them workable by hand-power; and being on wheels they are easily moved, so that one of them will answer for a good many ricks.

The pipes employed to connect the fan with the air-shaft are usually of iron, the diameter being 8 or 9 ins. The end of the pipe next the air-shaft is fitted with a damper which can be opened or shut at will.

It is unimportant whether the pipes are laid underground or on the surface of the ground, or at some height in the stack; but the air-shaft requires to be brought well down to the bottom of the rick, and should not be carried within 5 ft. or 6 ft. of the top of it.

An air-hole may be formed by using a corn sack stuffed with straw, and drawing it up as the rick is built, until the required height of the shaft is reached, when the sack is taken out altogether; or a framework of poles and laths may be used for the purpose.

The cylindrical form of rick is best, and it must not be too large. The smaller the rick the better, especially in the case of meadow grass, which, owing to the blades being so fine, packs closely and gets very dense. It is found that air cannot be rapidly drawn through the stack when the radius exceeds 8 ft. or 9 ft. If the rick is a long one it will require an air-shaft, or boss, for every 15 ft. or 20 ft. of length.

The temperature of the stack is best ascertained by the thermometer-stick, which does away with the necessity of having one or more thermometer-tubes in every rick. In a haystack the temperature should be kept below 100° Fahr.; and in a cornstack it should not be allowed to exceed 80° Fahr. If these temperatures are exceeded the fodder and the grain will be injured in quality and will lose in substance. Whenever, therefore, the temperature of the stack is found to reach 100° or 80°, as the case may be, the fan should be brought into operation. A very short time suffices to bring the heat of the stack down to the natural temperature; but the larger the volume of cold air drawn through the rick the better.

It is essential to the success of this method that, in haymaking, the grass be thoroughly shaken out in the field and allowed to lie a day or two and wither before it is carried. If that is done it may be stacked when not quite dry even, though that is not advisable in fine weather.

Unlike most valuable things, this one costs very little—the fan and all the fittings, complete, not more than £10 or £12; or about the value of 2½ tons of hay.

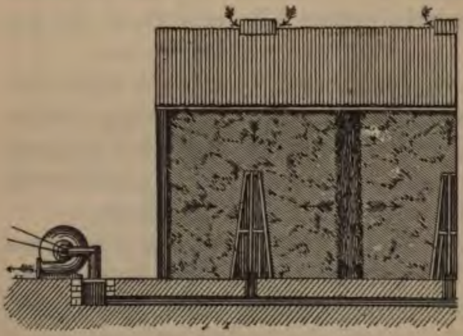


Fig. 71.

The illustration (Fig. 71) shows a longitudinal section of one of T. Pearson and Co.'s Single-span Iron Harvesting Sheds, 90 ft. long by 20 ft. wide and 14 ft. high to eaves, with hay stacked in bosses each 20 ft. long. An underground pipe with branches connects the different bosses with the air-vault under the exhaust-fan at one end of the shed. There is a damper, with rod to open or close at each boss. Ventilators are placed on the top of the roof over each boss.

The cost of applying Neilson's system to a shed of the above dimensions (90 ft. by 20 ft. by 14 ft.), capable of harvesting and housing about 96 tons of hay, will be as follows:—

	£	s.	d.
Cost of powerful fan for steam, water, or horse-power, capable of exhausting 108,000 cubic ft. of air per hour when going at 4,500 revolutions per minute, with iron knee-pipe for connecting with air-vault, or direct to underground pipe . .	9	15	0
4 dampers, with rod, at 14s. each	2	16	0
100 feet earthenware piping, at 5d. per foot . .	2	1	8
Thermometer, and 8 tubes for the same	2	5	0
	£16	17	8

Or about 3s. 6d. per ton of hay, exclusive of the shed.

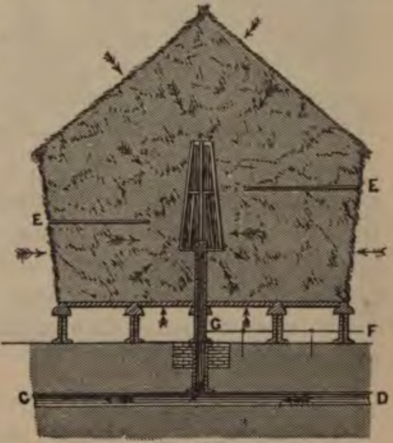


Fig. 72.

A. Cavity in centre of stack.
B. Hollow centre pillar of rick-stand.
C. Underground pipe leading from stackyard to exhaust-fan.
D. Underground pipe leading to other stacks.
EE. Tubes for inserting thermometer into stack to ascertain heat.
F. Handle outside of stack to open or close damper.
G. Damper.

Fig. 72 shows an arrangement for a series of stacks built upon T. Pearson and Co.'s Vermin-proof Rick Stands, with underground piping.

The engraving (Fig. 73) shows T. Pearson and Co.'s Hand-power Fan, operating upon a stack built upon the ground. In this case a wooden shute or pipe, B, is laid on the ground, one end terminating in the cavity, A, and the other at outside of the stack. The fan is connected with the shute by an iron knee-pipe, and can be attached or detached to or from the pipe in a few minutes, and carried from stack to stack easily by two men, and is thus available for cooling successively any number of stacks.

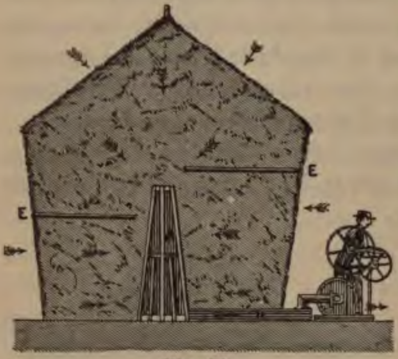


Fig. 73.

The cost of this mode of applying Neilson's system will be as follows:—

	£	s.	d.
Exhaust-fan, with knee-pipe	9	15	0
Wooden shute, 10 feet long, for connecting boss with fan, for each rick	0	10	0
2 iron tubes and thermometer	0	15	0
	£11	0	0

As the fan is available for any number of ricks, the outlay is proportionately smaller the greater the number of ricks operated on.

Fig. 74 is an illustration of Root's Blower or Exhauster, ventilating hay, straw, grain, and other ricks. *It is being* worked in connection with barn machinery by one of Bailey's water motors already mentioned. The blower is made in sizes capable of exhausting from 40 to 1,000 cubic feet of air per minute, and at a cost complete, without the motor power, of from £5 to £20.

Mr. Gibbs's system of harvesting is to dry the hay or corn sheaves before going into the stack. His plan is to employ hot air, which is forced into a perforated cylinder over which the wet grass or sheaves are passed in the drying chamber, until the forage is dry enough for the stack. Mr. Gibbs has also invented a hot-air cylinder for drying grain, tea, &c.; and various inventions of a similar kind have lately been patented by others for the purpose of drying and purifying damaged grain.

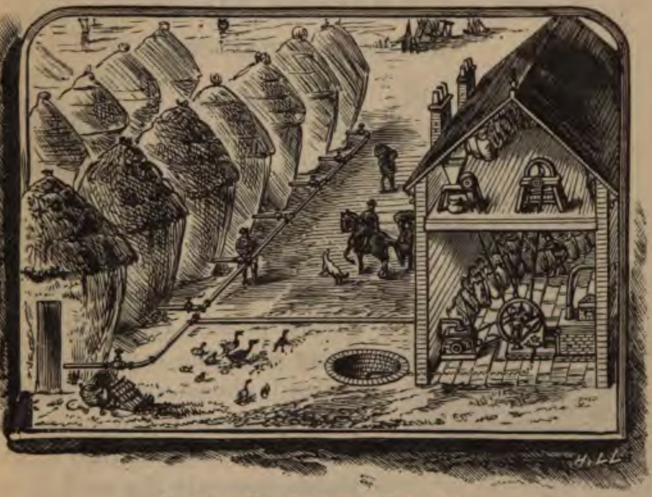


Fig. 74.—Root's Patent Extractor.

CHAPTER XV.

RICK-YARD APPLIANCES.

Rick Stands.—Fig. 75 shows one of the patent wrought-iron Vermin-proof Rick-stands, manufactured by Messrs. Bayliss, Jones, and Bayliss. They are made oblong or rectangular, as well as circular.

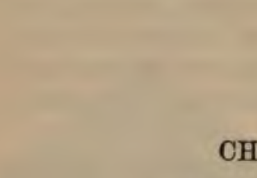


Fig. 75.

The use of these rick-stands effects an immense saving to farmers by preserving grain from damp and vermin, and by giving perfect ventilation. In many cases the expense of the outlay is almost covered the first year by the saving of grain, and the imperishable nature of the stands prevents the need of renewing during a lifetime if a little care is taken to paint them every second or third season.

The oblong rick-stand is suitable for wheat, oats, barley, or hay. It is made in the same way as the circular stand, no screw, bolt, or pin being required; and, like the circular stand, can be very quickly erected or taken down by a farm labourer. One advantage peculiar to this stand, however, is that it can be shortened 6 ft. at a time, as the grain is removed, so as to allow carts to get close up to the remaining portion of the rick. These oblong stands are also somewhat lower in price than the circular stands, and are better adapted for use under sheds.

Stacking Machines are now much used, and are of two kinds: (1) the "Horse Pitchfork," which takes the hay from the waggon and deposits it on the rick; and (2) the "Straw Elevator," driven in connection with the threshing-machine, or separately by a small horse-gear. In the latter machine the straw, &c., is thrown into the hopper of the elevator, whence it is raised to the top of the stack by means of endless chain-rakers.

Fig. 76 shows Walker's Improved Horse Pitchfork, by Coleman and Morton, and the mode of working it.

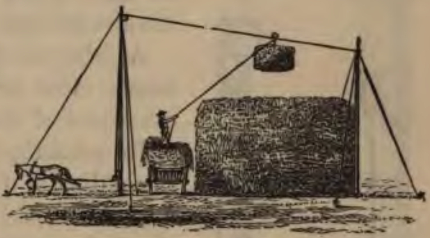


Fig. 76.

Its value in saving labour and expediting the stacking of hay can scarcely be overrated; in addition to which it has been extensively used for stacking barley and straw.

The fork is made almost entirely of steel, weighs only 8 lbs., and will take up as much hay at a single forkful as a horse can raise. It is very simple, not liable to get out of order, and can be managed by a boy. It will raise the hay to any required elevation and deposit it on any part of the stack.

The directions for working it are as follows:—

Fix two rick poles, one considerably higher than the other, firmly in the ground (and well stayed by guy ropes), the shorter one at the end of the stack, the other at a sufficient distance to allow of the waggon being unloaded midway between the two.

Fix one pulley at the top, the other near the bottom of the high pole. The rope, which should be 7-8ths of an inch in diameter, must pass through these two pulleys, then through the swivel hook pulley, which is to carry the fork and stretch across to the other pole, on which it must be made fast, so that when tight it inclines toward the stack.

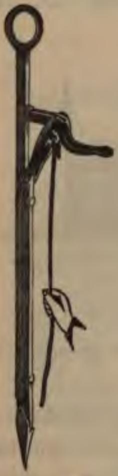


Fig. 76a.

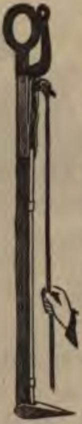


Fig. 76b.

A whipple-tree, for a trace-horse, must be attached to the other end of the rope.

In unloading the hay the sliding-pulley is drawn down to the top of the load; the man using the fork presses it into the hay as far as possible by the lever; the lever is then brought into a perpendicular position, so that the point of the fork forms a right angle (see Fig. 76*b*); the fork is hooked to the pulley, and, the horse being started, the hay is raised sufficiently high for the pulley to slide along the rope to the desired spot over the stack.

While the fork is thus elevated, the hand-cord attached to the small eccentric lever must be pulled by the man in the waggon, when the hay will be instantly discharged upon the stack (see Fig. 76*a*).

In unloading, the fork should be inserted alternately in the back and front part of the load, the best method of arranging which will be determined by a little *experience.*

Clay's Patent Piercing Stack Thermometer.—This (Fig. 77) is a simple instrument for testing the temperature of stacks, whether of hay or corn. It is only requisite to thrust the instrument into the side of the stack, anywhere, and allow it to remain there a short time. The thermometer, made specially for this purpose, being enclosed in an iron tube, readily answers to the temperature of the stack, and on being withdrawn the point at which the quicksilver stands is easily seen through the long sight-hole, as shown in the engraving.

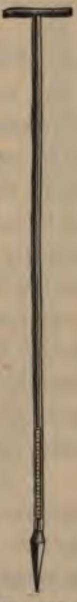


Fig. 77.

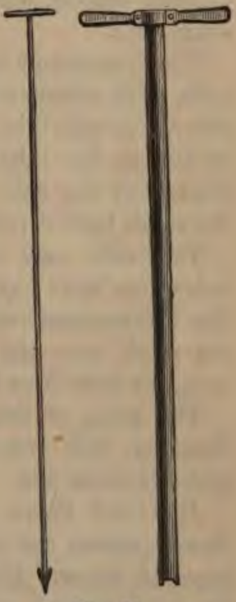


Fig. 78.

A red line is marked at 170°, at which point the heat becomes dangerous, and the stack may soon take fire, the actual point of ignition being about 200°. This thermometer is not only useful to those farmers who wish to adopt the new fan system of drying ricks, but to all those who desire to have a safe record of the temperature of stacks made in the usual way.

The price of the instrument, with improved bayonet point and key, and with registering thermometer in brass case, is 27s. 6d.

Clay's Patent Stack Tester.—This (Fig. 78) is a handy instrument for extracting samples of hay or corn from the outside to the centre of stacks, giving a much better idea of the bulk in case of a haystack than by merely hooking a small piece out here and there with a trial iron; whilst the taking of a fair sample of corn from the heart of the stack is a very difficult matter, which this little instrument entirely overcomes.

The instrument is made of a fine cold-drawn steel tube, with cutters at one end and a cross-handle at the other. A hole 2 in. in diameter is cut into the stack, by boring the tube into it, and the samples are extracted at the outer end, as the work goes on, with the small barbed rod used in connection with the tube.

This tube may be usefully employed for cutting holes into large haystacks for the purpose of inserting the thermometer-stick, when such stacks have become too solid, near the ground, for thrusting the thermometer into them by force of hand.

The price of this stack-tester, 7 ft. long, 2 in. in diameter, with cross handle and extracting rod complete, is about 30s.

Hay and Straw Compressors.— Various kinds of forage-presses are now in use for baling and trussing hay and straw. By this means these bulky crops can be so compressed that five or six tons can be put upon a truck instead of two tons as formerly, and thereby a great saving in railway carriage is effected. Less manual labour is also required than by the old method of hand-trussing; and the machine is very much more expeditious.

Hay-Knife.—The common hay-knife consists of a straight blade set at right angles to a short wooden handle. It is used for cutting hay or straw when consolidated in the stack. An improved hay-knife is shown in Fig. 79. This instrument has a serrated edge, and is double handled. It was awarded "First Order of Merit" at Melbourne Exhibition in 1880, and was also awarded the *first premium* at the International Exhibition in Philadelphia in 1876. It is an American invention, known as Weymouth's Patent, and is the best knife in use to cut fine feed from bale, to cut down mow or stack, or for cutting ensilage from the silo.

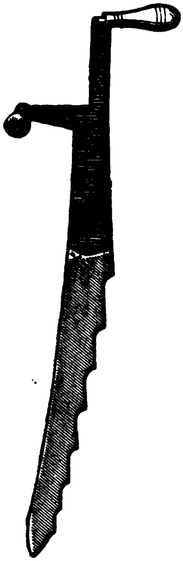


Fig. 79.

CHAPTER XVI.

APPLIANCES USED IN FEEDING STOCK.

Corn-Bins.—Stable bins should be large enough to contain a week's supply of corn for the number of horses to be fed by one man. For one horse, a 4-bushel bin will be large enough, but for a pair of horses the bin should have a capacity equal to 8 to 12 bush. Corn-bins are now mostly made of stout rivetted wrought iron, of which we give two examples (Figs. 80 and 81), by the St. Pancras Ironwork Company.

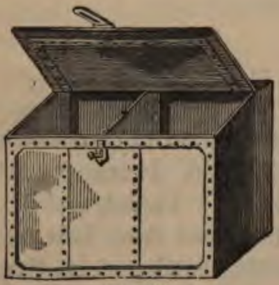


Fig. 80.

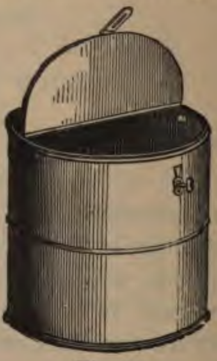


Fig. 81.

They are made of various shapes to suit different positions in the stable or hay-loft.

Feed-Sifters and Measures.—Figs. 82 and 83 show a sieve used for taking the dust out of corn and chaff before giving to the horses. Feed measures are usually made in ½ quartern, quartern, and ½ peck sizes.

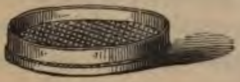


Fig. 82.

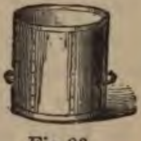


Fig 83.

Corn-Shoot and Meter.—This useful article (Fig. 84) is supplied by the St. Pancras Company. The meter is formed in the lower end of the shoot, and is so constructed that only one feed can be taken out at a time. It works easily and rapidly. The shoot may also be had with plain slides without the lever handle. Chaff-shoots may be had on a similar plan.

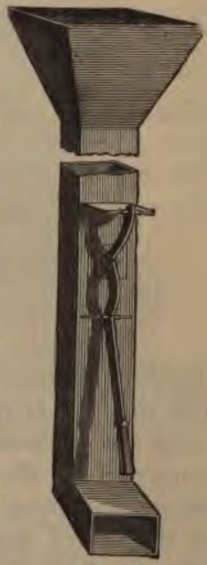


Fig. 84.

Automatic Horse-Feeder.—A very ingenious apparatus of this kind has been patented by J. P. Milbourne, of Manchester. It is intended to deliver food to horses at any hour in the day or night, thus obviating the consequences of unpunctuality or forgetfulness on the part of the attendant, and overcoming the evil of horses being turned out to work with an empty or nearly empty stomach. It consists of a shoot or spout, which is fixed over the manger, and some mechanism of which a clock forms part. The food is put into the shoot over night, and the clock can be set for any hour, on the principle of an alarum, and at the desired time half the food is shot into the manger, the rest falling half an hour later. By a modification, water can be supplied at the same time. One apparatus can be used for any number of horses, provided they are stabled in one building or in contiguous buildings, and it is equally applicable of course to cattle-feeding. It will be found valuable in busy seasons, and in cases where horses come home late at night, and do not require all their food or water to be given to them immediately. Horsekeepers are thus saved from sitting up late at night, or staying with their horses a long time after the day's work is over, as they do on farms in some parts of the country. It must prove especially economical where a large number of horses are kept, as at the desired time they can all have their food in the manger at the same moment, and thus avoid a great amount of neighing, pawing, and uneasiness. In stables not having a loft overhead, each manger is divided into two parts by a partition, one-half being covered by a lid. The food is placed in the manger,

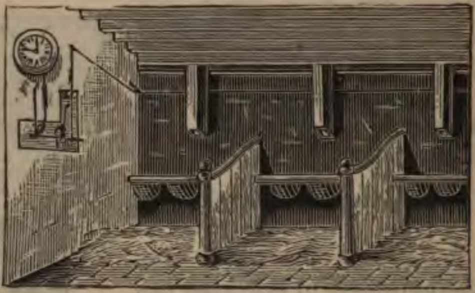


Fig. 85.

the lids closed, and at the desired time they are opened simultaneously, and the horses begin to feed.

Pig-Troughs.—For the pig-sty, the oscillating trough is superior to any other. It is usually made 6 ft. long and 4 ft. high, with cast-iron ends, prepared either for building in a wall or fixing to a railing. The trough has a circular bottom with divisions across, and has an oscillating flap or door suspended from the upper frame, which excludes the pigs from the trough entirely whilst the food is being placed in it.

For open-yard feeding, the improved circular trough, with hopper, is the best. It admits of food being poured into it while the pigs are feeding.

Cattle-Cribs.—The galvanized Cattle-crib (Fig. 86) manufactured by Messrs. Jones and Bayliss, is a great improvement on the old wooden ones, and being made entirely of wrought iron, are very strong and durable. They are usually made from 3½ to 4 ft. square and 9 inches deep; and at least four full-grown bullocks can feed at one and the same time from each crib. A great advantage of these cribs is that they are equally suitable for feeding cake, meal, roots, chaff, or uncut fodder. They are also as serviceable in the pasture field as in the cattle-yard.

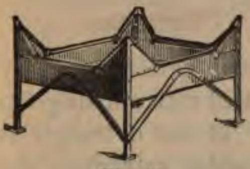


Fig. 86.

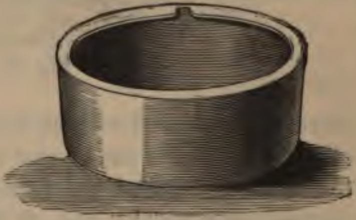


Fig. 87.

The round-lip Pans (Fig. 87), manufactured by

Messrs. Ransomes, Head, and Jefferies, are particularly to be recommended for feeding cake, &c., to cattle on the pastures. Being made of cast iron, the pans are so weighty as not to be easily upset, and the lip prevents waste of food otherwise. One pan is allowed to each bullock, so that each animal can get its full share of the food. The pans are made in sizes varying from 10 to 20 in. in diameter; and to contain from 1 to 9 gals. of either food or water.

Sheep-Racks.—This engraving (Fig. 88) represents a portable wrought-iron Sheep-rack, by Hill and Smith, well worth the attention of farmers. It is on four wheels; is covered with an iron roof, guttered to carry off the rain at the ends; and is fitted with a lifting-top for the reception of the fodder. It has a trough at bottom of wrought iron, 2 ft. wide, extending the whole length of the rack, which prevents waste of hay, and catches the hay-seed from the rack, and is also useful for feeding sheep with corn, oil-cake, salt, or cut fodder. It is capable of feeding upwards of a score of sheep at once, is very strongly made, to be drawn by one horse, and will travel without injury on the road.

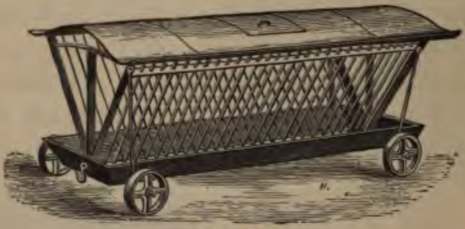


Fig. 88.

Sheep-Troughs.—Wrought-iron troughs are now fast superseding wood ones for sheep-feeding. Fig. 89

shows one of Hill and Smith's iron Sheep-troughs on wheels, so as to be readily drawn about by a lad. It can be used for food or for water as required. It is 9 feet long, and is made with a rod over the centre, from end to end, to prevent sheep from jumping over or getting into it, and it is so firm that it will not upset.

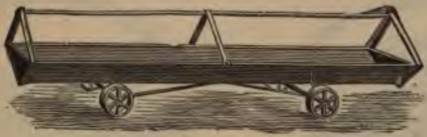


Fig. 89.

Calf-Feeder.—Tucker's Calf-feeder, shown in Fig. 90, is well calculated to facilitate the feeding of calves when brought up by hand. It is simply a tin vessel, holding a few quarts of milk, with a gutta-percha teat secured on the lid, and the end of the teat-tube almost touching the bottom of the pail. The teat has a valve, through which the fluid within is drawn by a slight pressure of the calf's jaws. The artificial suckler is far preferable to feeding young calves with milk in open pails. It is less wasteful to begin with; and the slower process also of drawing out the milk in the natural way by suction, instead of drinking it by mouthfuls, is more beneficial.

These feeders are also used for colts, which take to them readily; and in the event of a mare dying, or being needed for work, they will be found invaluable. In the latter case the dangerous effects of sucking the mare when overheated by labour are avoided.

Lamb-Feeder.—The Lamb-feeder (Fig. 91) is on the same principle as the calf-feeder. It is, however, fitted with six or seven teats, so that six or seven animals can feed from it at one and the same time. It has also been successfully used in the rearing of pigs. Both these feeders are supplied by the Aylesbury Dairy Company.

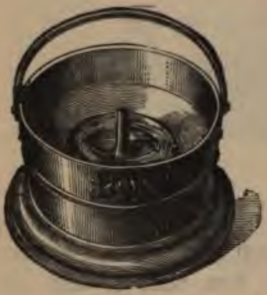


Fig. 90.

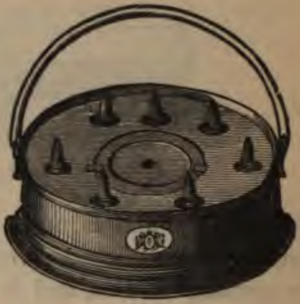


Fig. 91.

CHAPTER XVII.

DAIRY APPLIANCES.

Cow-Milkers.—Over fifty patents have been obtained for cow-milking machines, about fifteen in England and forty in America.

These machines have been divided into three classes:—

Tube-milkers, or tappers;
Sucking-machines; and
Mechanical hand-milkers, or squeezers and strippers.

Some machines are a combination of these classes. As yet, however, no one machine can be considered a success. Were it otherwise, these machines would speedily come into use. Various inventions have, no doubt, obtained a partial success in extracting milk from the udder of the cow; but until their action is at least as thorough and complete as hand-milking, they are practically useless. Every cow-keeper knows that any milking which is not thorough would soon ruin his cows as profitable yielders of milk; so that, important though a saving of the labour of milking is, it must not be purchased by any sacrifice of efficiency.

In the sucking machines, the milk is drawn from the teats precisely after the manner of the young calf. The calf draws a quantity of milk from the cow and then stops to swallow. So with the machine; as the handles are pressed together, the milk flows into the pump; as they return, it passes out through the valve into the pail.

Milk-Testers.—The instruments used for testing milk are the thermometer, the cream-gauge, the lactometer, the lactoscope, the pioscope, and the lactobutrometer. The value of milk-testers has, however, been but little appreciated by British dairy farmers in the past.

"In all those countries with which British dairy farmers have to compete, the farmer would be laughed at who would attempt the making of either cheese or butter without testing apparatus. A dairymaid would be surprised if you proposed to make butter or cheese without a thermometer, and even a complete set of testing-apparatus, to enable her to go to work scientifically and successfully." It is therefore satisfactory to note "that dairy farmers and town dairymen in England are becoming alive to their position in competition with the Continent of Europe, the United States of America, and our colonies."

The proportion of cream in any sample of milk can be determined by the cream-gauge, which is simply a glass tube, about 5 inches long, graduated from zero downwards. The milk to be examined is poured into this tube up to zero, and allowed to stand about twelve hours, at the end of which time the cream will have risen to the top, and its percentage may be read off. In good milk there should be at least ten per cent. of cream.

This instrument, although very useful to those who sell cream, is not reliable in detecting the adulteration of milk.

The lactometer, or hydrometer for milk, indicates the specific gravity of milk, that is, the relative difference in weight between milk and water. The specific gravity of water is 1,000, and that of milk may be taken to average about 1,030.

The specific gravity of milk varies, however, not merely with the amount of water it contains, but with the amount of butter fat in its composition, and for this reason the lactometer used alone is of little or no practical value. As cream is lighter than milk, and of nearly the same specific gravity as water, it follows that when milk is very rich or contains a large proportion of butter fat, its specific gravity is less than the ordinary standard, and if tested by the lactometer alone might give the idea that it had been watered. A cream gauge should therefore always be used in connection with the lactometer, in order to test the amount of cream or butter fat in the milk.

The best instrument for testing the value of milk hitherto invented is the so-called lactoscope. This shows, with considerable accuracy, the percentage of fat; and fat being the most valuable constituent of milk forms a safe gauge as to the purity and value of the milk.

The action of this instrument depends upon the fact that the opacity of milk is chiefly caused by the globules of cream. So that when water is added to milk until we can see through a certain proportion of it, we are able to do so because we separate the cream globules to that extent that light can pass through between them with a certain degree of clearness. Then, if we measure the amount of water added, we have quite an accurate gauge for comparing different samples of milk.

The lactoscope, however, as well as the pioscope and the lactobutrometer, is less simple than the cream gauge and the lactometer, and therefore less suitable for ordinary use in the dairy.

Refrigerator.—Lawrence's Capillary Refrigerator, of which we give an illustration in Fig. 92, is one of the most profitable appliances for the dairy.

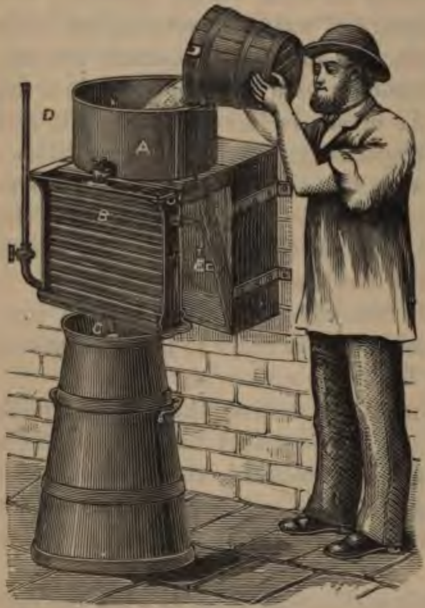


Fig. 92.

A, warm-milk receiver; B, refrigerator; C, milk exit; D, water inlet; E, water exit.

By the aid of these refrigerators, the milk intended for transit, or for the making of butter or cheese, may be cooled as soon as it leaves the cow, and before any injurious change can possibly have taken place. It is now well known that milk is preserved in proportion to the rapidity with which it is cooled. The explanation of this is that, when milk is suddenly cooled, the floating germs, which are the cause of decomposition, are destroyed, and the milk is consequently preserved; whereas if cooled by slow degrees, living infusoria will still be found in it.

By passing warm water through the refrigerator, *instead of* cold, the temperature of the milk may readily be raised to any degree required, which, in cold weather, is a great advantage in cheese-making.

The refrigerators are made in sizes capable of dealing with from 80 to 250 gallons of milk per hour.

Milk-Strainers.—The milk as it comes from the cowhouse requires to be put through a strainer to insure it being free from straws, &c. The strainers in common use are shaped like a cup or bowl, and have fine brass wire sieve bottoms, in addition to which a straining cloth is sometimes used.

Milk-Pans.—For shallow setting the pans now most recommended are of the pattern shown in Fig. 93. They are enamelled white inside, black outside; cool, sweet—being readily cleansed—and presenting a large cream surface. Milk pans may be had in white porcelain or in tin. The latter are blocked out of one piece of steel, and are without seam or joints.

Milk-Stands.—The old plan of setting the milk-pan upon shelves around the dairy walls is being fast abandoned in favour of portable disc stands, after the patterns shown in Fig. 93. These are not only portable but revolving disc stands. They utilise space, as they can be placed in line or in square; while the revolving discs or tables allow of skimming each pan without moving from one position.

Being portable, they can be placed in the most desirable position for ventilation, and for thorough cleansing of the milk-house walls, which fixed shelves do not admit of.

Deep Setting.—The deep-setting system is coming into general favour, and is fast superseding the old shallow-pan method of cream-raising. The theory that shallow setting promotes quick rising is exploded, while it is now well known that the souring of milk is due to the development of germs which are always floating in the atmosphere, and are sown, like seed, to flourish when they fall on suitable soil. Of such a soil the shallow pan exposes a very large area, while the deep pans expose but little.

It is claimed by the advocates of the deep-setting system that warm milk suddenly immersed in cold or iced water, throws up sweeter cream in larger quantities, and in less time, than when set in shallow pans. It also requires less space, and the butter made from it is said to keep better.

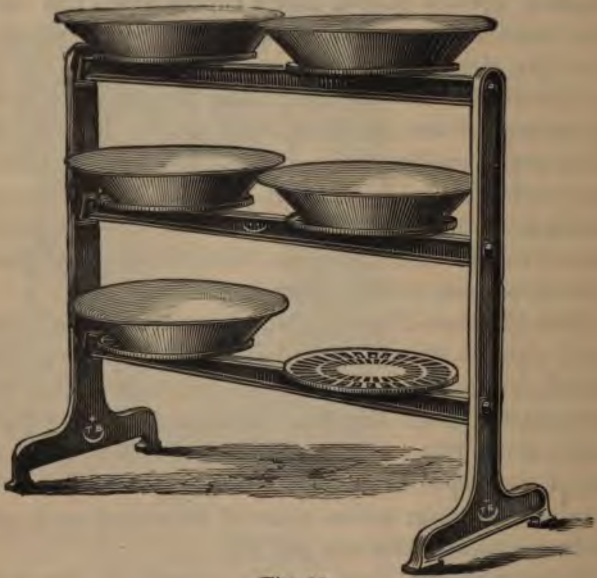


Fig. 93.

The Swartz System.—The " Swartz " Pan, so named after its inventor, was the first deep pan introduced *into* England. These pans are placed side by side in a trough or cistern filled with cold water (Fig. 94), and through which, if convenient, a slight stream is allowed to flow. The trough, with inlet and outlet taps, &c., to hold water for immersing the pans, may be constructed of wood, stone, slate, or brick, either above ground or in the floor of the dairy.

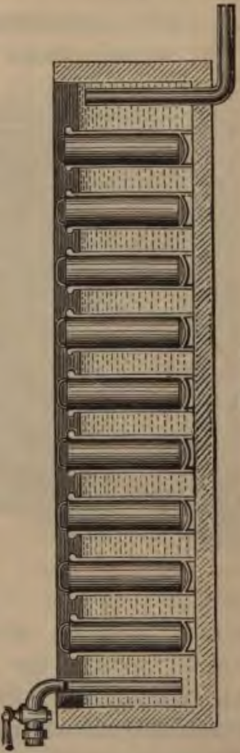


Fig. 94.

Fig. 94 shows a longitudinal section, and explains the manner in which the pans and taps are arranged. The "Swartz" pans, it will be observed, are narrow and oval in shape. They are made of the best tin-plate, with tinned iron bottom hoops and handles, and usually of a size to contain 40 qts. of milk each.

Cooley Creamers.—Among American dairymen Cooley's Portable Creamery is much in favour for deep setting. Under the "Cooley" system the milk is strained into cans 20 in. deep and 8 in. in diameter, each covered with a small inverted pan, and the cans are all packed in a closed box, which is then filled with cold water, a constant cold stream passing through the box, or ice is used to keep the water cool, and the pans keeping the water out of the milk on the principle of the diving bell. It is found that all the cream rises within twelve hours, and owing to the temperature of the water being kept below 50°, the skimmed milk is perfectly sweet, and is used for cheese-making and other purposes.

Fig. 95 is a tranverse section of the Cooley Creamery.

The animal odours and gases are more effectually disposed of by this process than by any other, for the reason that the covers do not fit closely down on the cans, thus securing a free circulation from the milk into the water through the air confined under the cover; at the same time the water most effectually seals the milk from any contact with the atmosphere, and as the milk when placed in the cans is at a temperature of from 80° to 90°, and the water from 45° to 55°, the natural effect is for the odours and gases of the milk to rush into the water and be immediately absorbed by it.

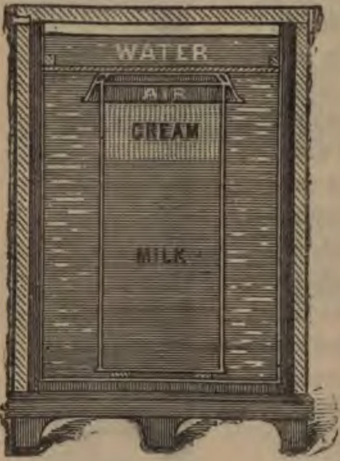


Fig. 95.

To determine the size of a creamer required for a dairy of a given number of cows, the following calculation will be found approximately correct, reckoning the capacity of the cans at 16 qts. each.

For a dairy of	1 to 3	cows, 1 creamer	with	1 can,	16	quarts.
,,	4 to 6	,,	,,	2 cans,	32	,,
,,	6 to 9	,,	,,	3 ,,	48	,,
,,	9 to 12	,,	,,	4 ,,	64	,,
,,	12 to 18	,,	,,	6 ,,	96	,,

For a dairy of	18 to 24	cows, 1	creamer with	8	cans,	128	quarts.
,,	24 to 30	,,	,,	10	,,	160	,,
,,	30 to 36	,,	,,	12	,,	192	,,

Cream-Separators.—The separation of milk from cream, which is slowly effected by gravitation in the pan-setting systems, is brought about instantaneously by means of the Centrifugal Cream-Separator, which is a machine of comparatively recent introduction. It consists, in its simplest form, of a milk drum or cylinder, which is made to revolve at a very high speed, and in the process the milk being poured in, the light cream globules gather around the axis, and are drawn off separately, whilst the heavier milk globules are thrown outwards towards the circumference, and discharged by another pipe.

This ready method of separating the cream is of great importance where sweet cream butter is wanted, and still more so where the skim-milk is sold, as it can then be sent off quite fresh, and will, consequently, bring a better price. It has been conclusively proved that the machine extracts more cream from the milk than can be raised by the open-pan system. It is said that the machine-extracted cream also yields more butter.

In an extensive series of experiments tried in a Danish dairy of 200 cows, where the three systems of cream-separating were tested, viz., the centrifugal machine, the Swartz system of deep cans set in cold water or ice, and the shallow-pan system, the results of some two years' working were altogether in favour of the machine. The average proportion of cream left in the milk was only ·35 per cent. of the centrifugal system, and occasionally it was as low as ·15, while it was ·62 per cent. with the Swartz cans, and ·68 per cent. with the shallow pans. It was stated as the result of the whole set of experiments that the centrifugal system gave over 8 per cent. more butter from the same quantity of milk set in ice on the Swartz system, and over 10 per cent. more than the shallow-pan system. The best evidence in favour of the machine, however, is, that it can extract cream from milk that has been previously skimmed on the old method.

It has been observed in different experiments with the separator that the skim-milk makes a poorer quality of cheese than ordinary skim-milk. This is, of course, due, in a great measure at least, to more of the cream having been removed. Complaints are occasionally made that the skim-milk from the separator does not keep sweet so long as ordinary skim-milk, but this can easily be remedied by scalding the skim-milk when it is to be kept for any length of time. And, indeed, in order to obtain the best results, milk should be about 90° Fahr. when run through the machine.

A great many varieties of centrifugal cream-separators have been brought out, but only two of them, viz. the Swedish or Laval Separator, and the Danish Separator, have as yet been favourably reported on in this country.

The Laval Separator, which is perhaps the best-known machine, does its work well, and is a cheap article, costing only £32, and separating 60 galls. of fresh milk per hour; but the difficulty is, it does not seem possible to enlarge or reduce it in size. Its revolutions are also very great, and the power required to drive it considerable.

Fig. 96 is a section of this machine. The milk as it comes from the cow is placed in a milk-can, and delivered by means of an ordinary tap into the funnel *a*, and through the small tube *g*, connected with the funnel, into the rotating vessel A, which runs at a velocity of 6,000 or 7,000 revolutions per minute. To the bottom of the funnel is soldered a thin wing, which forces the milk to follow the rotation of the vessel.

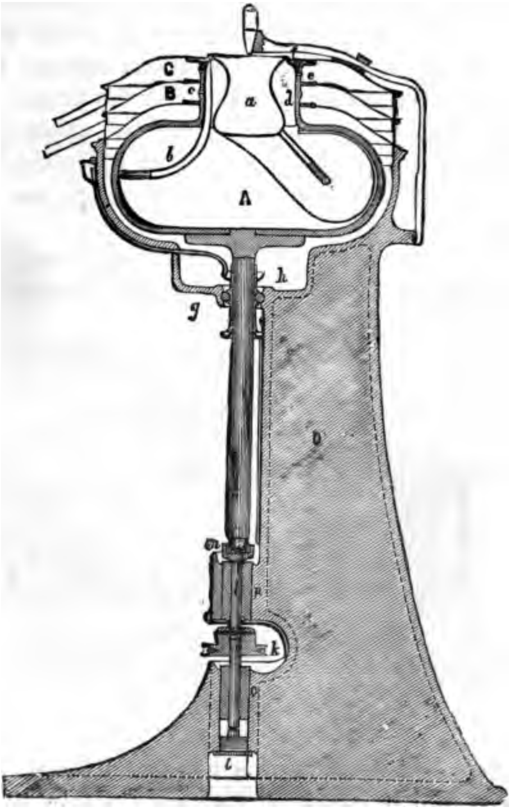


Fig. 96.

As soon as the fresh milk enters the rotating vessel, an instantaneous separation takes place. The heavier portion, or the skim-milk, is thrown towards the circumference of the vessel and forced up the bent tube *b*, whence it is delivered through the aperture *c* into the lower of two tin trays or covers B, which is provided with an outlet pipe. The cream remains nearer the centre, rises around the outside of the funnel *a*, and through a small hole in the cylindrical upper part of the rotating bowl it delivers itself at *e* into the upper cover C, whence it is discharged through an outlet pipe.

The opening *e* is regulated by means of a small screw *f*. In making this hole narrower the cream obtained will be thicker.

The Danish Separator (Fig. 97) is made in two or more sizes. It consists of a horizontal drum, in the centre of which is a metal cone, and within this the driving shaft.

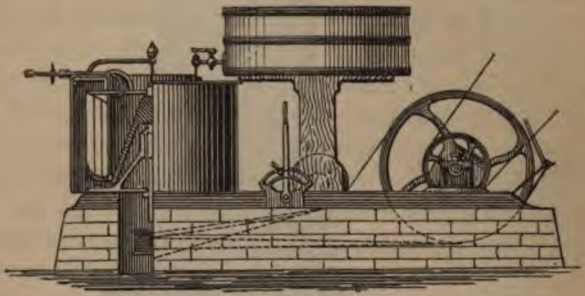


Fig. 97.

A section of the machine is shown at Fig. 98. The skim-milk escapes at B, and is drawn off by beak and tube C and D. The cream when gathered in sufficient *thickness, is* drawn off by the beak E, and tube F.

If thin cream be required the cream is drawn off continuously, but if thick cream be required the beak E is put into work when desired, that is to say, when the wall of cream is seen to be of sufficient thickness. This power of regulating the quality of the cream is one of the most valuable points in the Danish Separator.

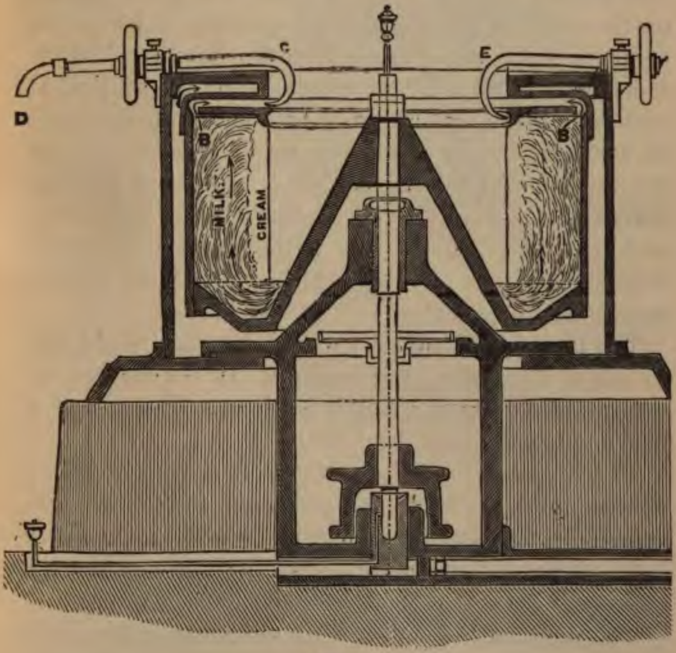


Fig. 98.

The latest of these machines is fitted with a regulator by which the quantity of cream to be taken off is regulated exactly. "Thus, where cheese-making is combined with butter-making, it may be advisable to leave the skim-milk rich or to sell it rich. To this end the milk as it leaves the vat above pours through a little vessel, in the two corners of which are tubes which screw down into the feeder of the drum. These permit a larger or smaller quantity of milk to escape into the separator at will, the quantities being marked on the rod. When the normal quantity is let in, the cream is all taken; if more, then the skimmer does the same work with a larger volume of milk, so that it naturally takes less cream. Another improvement is an arrangement by which the revolutions are counted per minute, and this is very exact; a cogged wheel is driven by the revolving shaft, this moving a figure at each revolution, and so on, until, by the aid of the watch, hundreds of thousands of revolutions can be accurately timed."

The Danish machine only works at a velocity of 1,800 to 2,000 revolutions per minute. It is capable of separating 120 galls. of milk per hour. The cost of a machine to do this is about £80.

Churns.—An immense variety of churns are now offered by manufacturers, and new forms are constantly being introduced, but the best of them differ but slightly in principle from one or other of the old churns.

The simplest and oldest form of churn is the *dash-churn.* This consists of a long narrow tub, tapering upwards to allow of tightening by hoops. It has a lid, and in that a small central aperture, through which works a staff or handle, having on the bottom of it, inside the cylinder, a round disc of wood with a number of holes cut in it. The diameter of this disc or piston, is something less than the upper diameter of *the cylinder.* The simple motion perpendicularly of the handle upwards and downwards works the piston at the bottom, through the cream, and agitates it sufficiently to cause it to throw up the butter in lumps. This churn may be worked by hand or power, but it is less effective than most of the other churns we have to describe, and is now in fact seldom used.

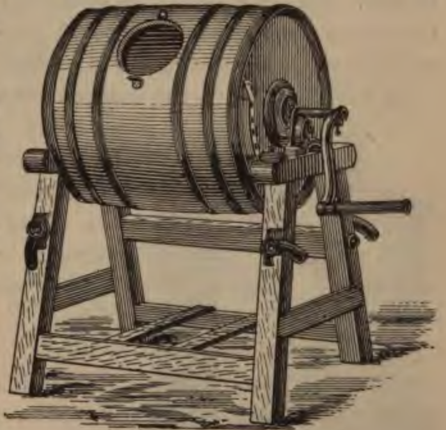


Fig. 99.

Hathaway's Improved Barrel Churn (Fig. 99) is a very serviceable one. It is a plain barrel or cylinder, having a hole in one side, through which the cream is admitted and the butter extracted. Over this hole is a plate of metal or wood, which can be screwed down, a piece of cloth being first placed between the parts. In the centre of each end of the barrel are securely and accurately fixed two gudgeons or spindles. These are placed in proper bearings set upon a strong frame, and on one end of the gudgeons, or both, are placed winches, by which the barrel is made to revolve. In the interior of it, parallel with its axis, and secured to it, are pieces of board radiating from its centre. These agitate the milk as the barrel is turned.

The chief defects of this churn are a too great tendency to carry the milk round with the barrel, and the difficulty of getting at the interior to properly cleanse it after churning.

Another barrel churn is made in which the barrel remains stationary, and a central shaft, upon which the dashers are fixed, is made to revolve. The operation is much the same as in the other barrel churn, except that in one case the milk is worked against the dashers, while in the other the dasher is worked against the milk.

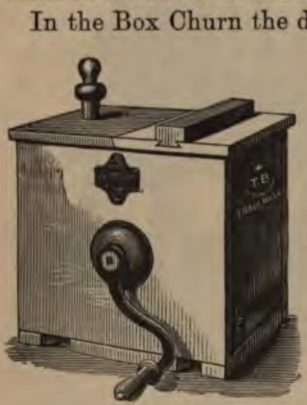


Fig. 100.

In the Box Churn the dashers usually revolve on the spindle; but, in cases, the churn revolves, as with Hathaway's barrel churn, the only difference here being that the box churn is square or rectangular in form.

Fig. 100 represents Bradford's "Declivity" Box Churn.

One-half the cover of this churn is a fixture, and therefore effectually prevents back slop or leakage; while the movable half affords ample space for taking out the dash and cleaning the interior.

The two wood-set screws are to tilt the churn when either an unusually small or an exceptionally large quantity of cream has to be churned. In the former case the cream is collected at the lowest point of the churn and gets the full benefit of the dash, and in the latter case the capacity of the churn is largely increased, as the cream will not leak at the end of the spindle even with a larger quantity—say, one-fourth—than *the churn will* hold on the level.

An essential difference in the various box churns is in the shape of the dasher, one form of which is shown in Fig. 101.

For a small dairy of one or two cows the box churn is as good as any, and can be easily taken to pieces and scalded.

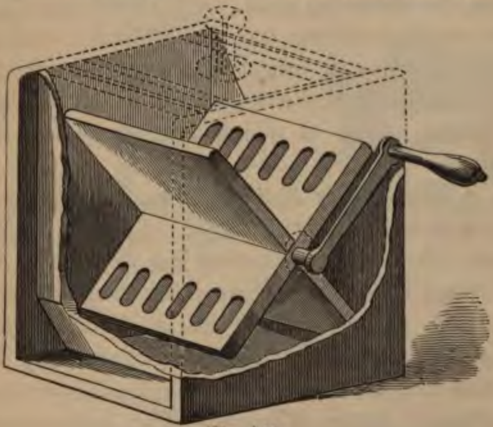


Fig. 101.

All the recent improvements in churns are embodied in Bradford's new patent "Diaphragm" Churn (Fig. 102). It is made in various sizes, suitable either for hand, horse, or steam-power.

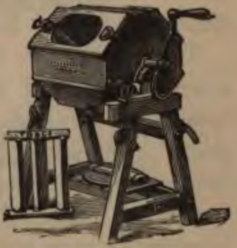


Fig. 102.

The construction of this churn is very simple—octagonal, with unequal sides, the interior perfectly plain but having a moveable screen with partitions so arranged that as the butter forms the globules have a tendency to aggregate, without risk of bruising from violent contact. When the result is obtained the diaphragm is moved, and the butter-milk drawn off. The churn is fitted with two diaphragm divisions, one for churning cream, the other, or converging current division, for churning milk.

Various other churns, too numerous for even a brief description, are still largely in use. Amongst these are the Midfeather, the Eccentric, and the Cotswing churns, the names of which are suggestive of their differences.

For a large dairy the "diaphragm" churn is the best now in the market.

Never allow water, whether hot or cold, to remain in a churn; after using, cleanse the churn with a dairy brush, and then simply rinse with boiling water, leaving the lid off so that the churn may become sweet and dry as soon as possible.

Mechanical Butter-Workers.—The butter-worker is one of the most necessary implements in the dairy. It is simply a matter of impossibility to work out all the whey from the butter by hand kneading, and the few particles not expelled act as a ferment, and prove the fertile cause of butter so soon turning sour or contracting a cheesy flavour.

These machines work the butter perfectly, and expel every particle of whey without the hands having to touch it at all, and butter so made commands a better price. No dairymaid having once used the butter-worker ever dreams of doing or trying to do the same work by hand. In all the best butter dairies the produce is now turned out without ever once having been touched by the hand.

For very small dairies the Board-and-Roller Butter-*worker (Fig.* 103) will be very suitable. The open end of the board rests upon a table or other convenient support.

For medium-sized dairies, Bradford's Improved "Turnover" Combined Butter-Worker and Dairy Table (Fig. 104) is recommended. This is a convenient and powerful butter-worker. The table top folds up and covers the butter-worker, and when this is lifted off, there remains a most convenient dairy table for general purposes.

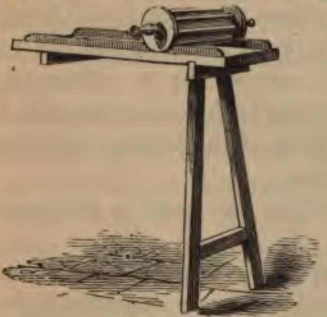


Fig. 103.

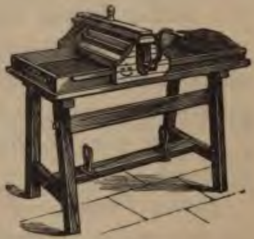


Fig. 104.

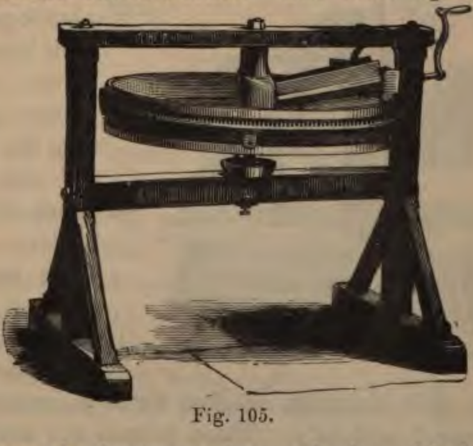


Fig. 105.

Fig. 105 gives a view of Bradford's "Springfield" Prize Butter-Worker. It differs from the "Embree" butter-worker in having its revolving table hollowed towards the centre, which allows the whey to fall freely through an opening specially provided in the centre, the butter being worked *upwards* by a differential motion of the fluted roller towards the outer rim, which effects a more efficient working of the butter, and with greater certainty, in less time.

Larger sizes of this machine are made to suit horse or steam-power.

Butter-Presses.—It frequently happens that the market value of really good butter is depreciated by want of skill and taste in the making of it up in sharp, well-defined pounds or half-pounds. To simplify and insure uniformity in this process, a simple machine, on the principle of a brick-press, has been brought into use, and will in time entirely take the place of the old wooden hands or butter-beaters. With these admirable presses, even in the hands of an inexperienced person, this desirable market form is secured with mechanical certainty. These presses are made with round or rectangular prints carved to any design. Fig. 106 is an engraving of a butter-press supplied by the Aylesbury Dairy Company.

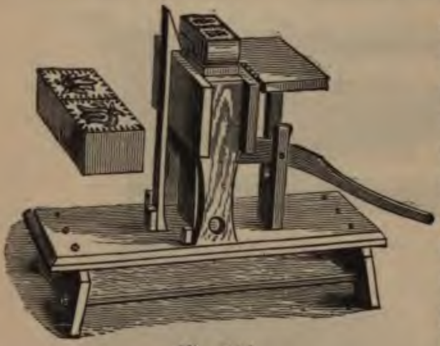


Fig. 106.

Cheese-Making Apparatus.—Considerable improvements have been made within the last few years in the various implements and utensils used in cheese dairies. These consist of milk-vats, curd-mills, vat-sieves, curd-cutters, curd-shovels, draining-racks, and cheese-presses, &c., &c.

Milk-Vats.—One of the most recent changes in cheese-making apparatus is the use of square or long vats in place of the old-fashioned round vats. The square vats admit of greater facility in cutting up the curd. These vats have now been exhibited for two or three years at the leading dairy shows, and have invariably carried off the awards in competition with the old round ones.

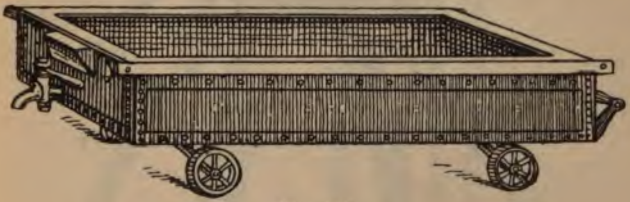


Fig. 107.

Curd-Mills.—Fig. 108 is a drawing of H. Bamford and Son's Curd-Mill. All the fittings and bearings of these mills are galvanised, easy of access, and not liable to get out of order. The framing is of iron, and where desirable, malleable, instead of the ordinary cast iron is used, wrought iron being employed in parts.

The same mill can be had without the stand, and adapted for fixing on the top of a cheese pan or tub.

Cheese-Presses.—The varieties in cheese-presses are so numerous that we cannot even attempt to specify them all.

Fig. 109 represents one of H. Bamford and Son's Improved Iron Cheese-Presses. They are made single or double. The use of wrought iron where necessary gives strength; they are light, can be easily moved, and stand within a small space. There is also the least possible labour attending their management; by merely turning the screw, the weights are raised and the pressure is then continuous, and does not diminish as *the cheese* sinks by compression. There are four

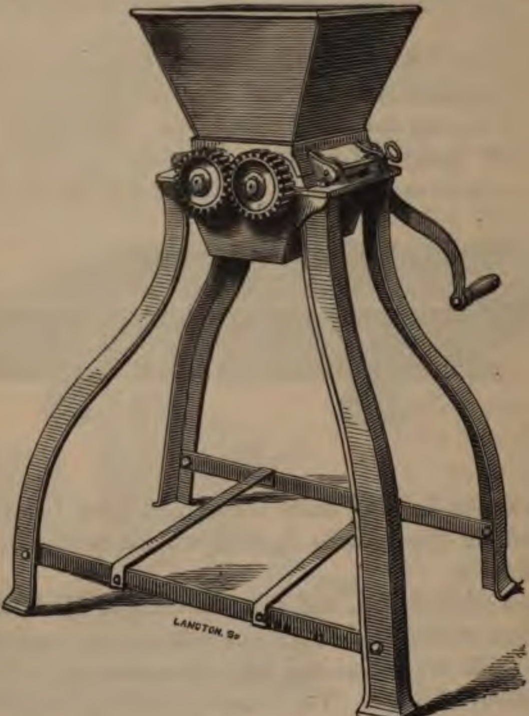


Fig. 108.

weights supplied, the whole or a portion of which can be used as the state of the cheese requires.

An apparatus for making soft cheese is much used by continental dairymen. It consists simply of a large stage with long and short boards for dividing the masses of curd to form the cheeses. Special moulds and strainers are also used for cream cheese-making.

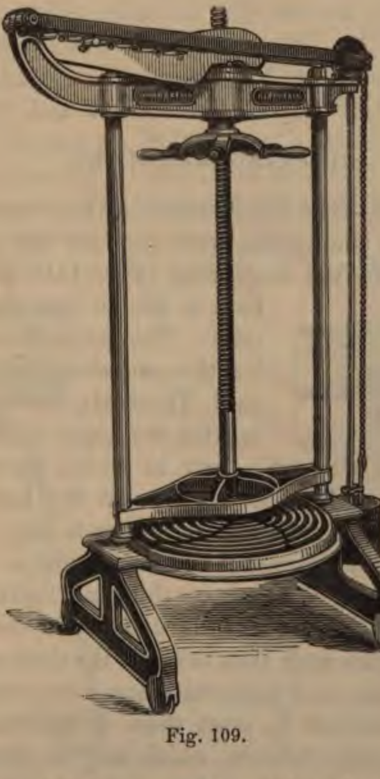


Fig. 109.

CHAPTER XVIII.

CLIPPING MACHINES.

Sheep-Shears.—The Sheep-shears in most common use have a single bow spring, with the bow and blades all one piece. In the engraving (Fig. 110) the shears have a double bow united by a rivet. The latter tire the hand less than any shears we have ever used. This is of great importance, as with the single-bow shears it is very difficult to get a pair in which the tension of the spring is such as to exactly suit the hand of the operator; whilst it is also necessary to employ shears having a spring of greater or less tension as the wool may be heavy and strong or thin and light. Again, the hand of the workman is stronger in the morning when he begins work than towards the close of the day, at which time less powerful shears are preferred. It has been designed to meet these difficulties by providing a movable fulcrum, which may be fixed at any point between the sides of a spring having parallel sides, so that by moving it from one end to the other, the tension can be regulated, and a single pair of shears thus made to answer all the requirements of the shearer. The fulcrum is preferably formed of a short coil of *steel wire, of* a diameter just sufficient to fill the space

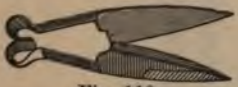


Fig. 110.

between the sides of the spring, which it clasps on one side through the ends of the wire being slightly hooked, whilst the elasticity of the coil makes it cling to the spring and retains it in its place, allowing it at the same time to be easily moved to any desired point. The friction of the fulcrum on the two parts of the spring further prevents, with the grip of the hand, any tendency which the blades have to slip by each other, commonly known as "buckling." This device is equally applicable to shears, the blades of which are united by a rivet, it being only necessary to introduce a spring on which to attach the fulcrum.

Horse-Clippers.—Fig. 111 is a representation of Clark's well-known instrument for clipping horses. It has now been many years before the public, and is acknowledged to be the best and cheapest in the market. In using this clipper, all that is necessary is to hold the instrument level and steady on the skin,

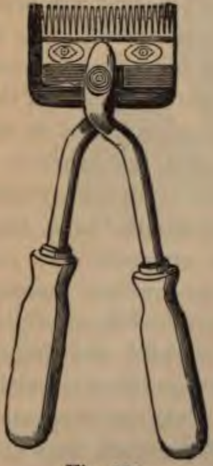


Fig. 111.

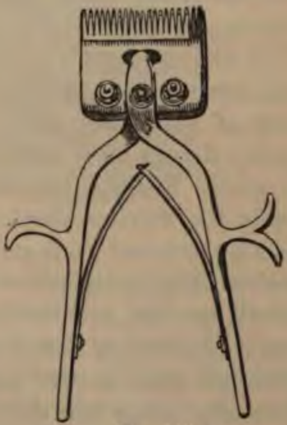


Fig. 112.

pushing the lower blade forward as fast as possible, while working the upper blade or cutter by an oscillating motion.

Fig. 112 shows a one-handed clipper, for heads, manes, quarters, and difficult parts, leaving one hand at liberty to hold the horse, thus enabling the clipping to be performed by one man only. Each of these machines can be used for sheep-shearing.

In Clark's larger apparatus for clipping horses or sheep, a new principle in mechanics has been developed. This is a flexible shaft, through which the power is communicated from the driving-wheel to the shears, which are kept rapidly clipping as long as the driving-wheel turns, no matter in what position they are held, nor how much the driving shaft is contorted, even to bending it around the animal being clipped or shorn. This driving shaft is a spiral brass wire, one end of the coil being connected with a small wheel attached to the butt of the blades of the shears, and the other to a pulley driven by a band on the end of an arm, which is partly flexible, attached to the small frame that holds the driving-wheel. On the opposite side are another arm and shaft and shears for another shearer, each working independent of the other, and the machine, it will be seen, can be fitted with a third and fourth rod if required, so that from one to four animals can be operated upon at the same time. Or, in clipping a horse, by using two driving-rods, one man may clip the upper and another the lower and under parts at the same time.

The drawing represents a perspective view of the driving apparatus. Each turn of the wheel produces 32 cuts, and as a boy can easily produce from 80 to *90 revolutions* per minute, the extraordinary speed is attained of 2,560 cuts per minute, with each driving-rod or set of shears.

Hedge-cutting and Trimming Machine.—An ingenious machine for cutting and trimming hedges has been introduced by Messrs. R. Hornsby and Sons, Limited. Its capabilities have been thoroughly tested on hedges of all kinds, with the result of proving that it is able, cheaply and expeditiously, to accomplish what has hitherto been a laborious and costly operation. The hedges which have been cut by these machines are growing well, and have become full growth from the bottom to the top. Its general appearance is shown in Fig. 113; the following particulars will enable its mode of working to be clearly understood:—The machine is mounted on two road wheels of large diameter to secure light draught. Both wheels are employed in driving the working parts, the motion being communicated by an arrangement of gearing to one of a pair of knives, similar to the knives of mowers and reapers, but larger and of greater strength. These knives are carried by a sliding bar projected from the side of the machine. This bar with cutting apparatus

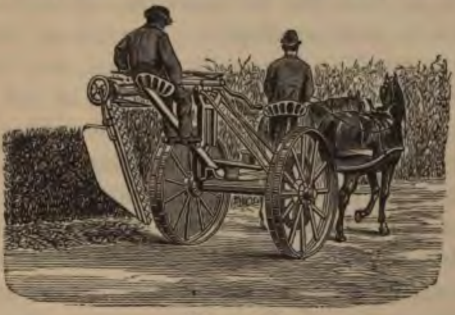


Fig. 113.

is so arranged as to be capable of ready adjustment to suit different circumstances; the entire machine when set for work being under complete control of the man in charge, who rides upon a seat conveniently placed for making all necessary adjustments. The cutting apparatus can be raised to any required height to suit high or low hedges, or the level of the ground on which the machine may be travelling. It can also be set at any required angle, to cut more or less off the hedge, and to reduce its height or alter its shape as may be desired. Both sides of the hedge may be cut from the same side, so that the machine may be kept on that side which is most convenient. The side of the hedge nearest the machine is usually cut first, and then the bar lifted over the hedge and the angle of the inclination reversed, so as to cut the other side. The top may afterwards be trimmed if required (though this is not usually necessary), by setting the cutting-bar straight out from the machine, and the height the hedge is required to be left. The cutter-bar being constructed on the same principle as the paragon mower, swinging round the crank spindle, will work equally well on either side or at the top, and at any angle of inclination. The hedge when cut is Λ-shaped, of any required width at bottom, and of any height. The machine is worked by two horses, and requires only a youth to drive, and one man to manage and control the cutting, and the work accomplished is about five miles of hedge, cut on both sides and at the top, per day.

CHAPTER XIX.

POULTRY-YARD APPLIANCES.

Incubators. — Artificial incubators will be found a decided advantage, especially where very early chickens are wanted, or only laying fowls, that is, non-sitters, are kept.

Fig. 114 is a sectional view of Christy's Patent Thermostatic Incubator, of which our space will afford only a very general description.

A is a valve acting upon B, the mouth of air-shaft; C, rod connecting valve with the thermostatic band in the egg-drawer; D, the set screw for regulating the temperature; E, the screen protecting the valve A and the lever; F is the filling pipe; H, the top of the chimney, in the centre of which is the boiler; H* is the circulating boiler; I, lamp screen and stand; L, air-holes; M, the front of the drawer; N, the thermometer; O, the lamp; P, the wood slide to push lamp close up into the chimney; Q, the thermostatic band—when cold it follows the dotted line, when working it is pressed down at end attached to C by the power of expansion; R, R, circulating pipes; S, collar fitted at bottom of H; T, evaporating pan, covered by canvas; U, water-tank.

The rules for working are as follow: Fill the tank with hot water. Light the small lamp and set the regulating valve at the heat desired. After the eggs are placed in the drawer, if the lamp is trimmed morning and night, and the eggs turned once a day, no further attention is required.

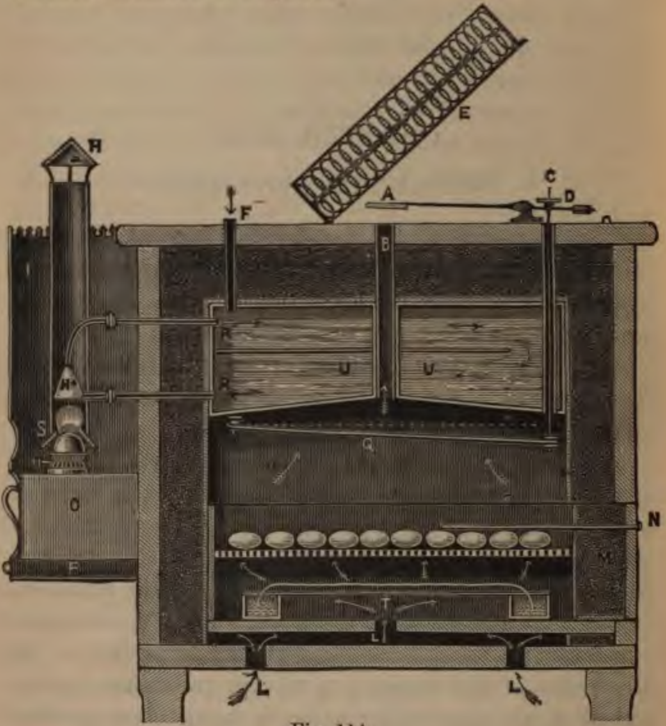


Fig. 114.

The perfect ventilation provided in this incubator renders its successful working a matter of certainty.

Rearers.—Fig. 115 shows Christy's Open-Air Rearer, which is heated in precisely the same way as the Incubator, by filling it with boiling water through a funnel, leaving it for twelve hours, and afterwards keeping up *the temperature* by a supply of boiling water once or twice a day, from one to two gallons each time, or more, if necessary. The operator must judge the quantity, according to the temperature of the atmosphere, making allowance for its variations, and also proportionately to the number of chicks in the artificial mother. The best temperature to keep up is about 60° to 70°, but by pressing the hand up towards the loose flannel, lining the bottom of the cistern, it can be at once determined if the heat on the backs of the young birds is sufficient or not.

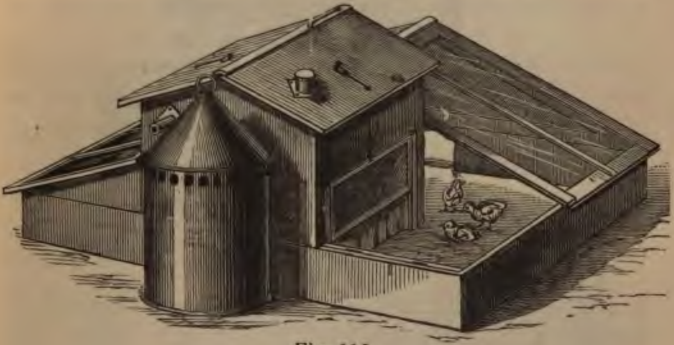


Fig. 115.

The first night or two the sliding ventilated zinc doors can be closed, if judged advisable, and if the weather is very cold; but afterwards they should always be raised during the night, for if the chickens feel cramped for space, or too warm under the mother, they should be able to go outside into the fresh air.

Leaving open the zinc slides is also a guarantee against the danger of crushing and trampling, as, if the weaker ones are pushed by the stronger chicks, they simply come out into the tray, run round to the other side, and go in there.

Cramming Machine.—Several French Cramming Machines exist, but in all of them is the fatal defect that they are only available for liquid food. Fig. 116 is a sketch by Christy of an English-made Crammer, which is sufficiently powerful to feed with almost dry food. It is worked with a wheel, which forces a plunger down the cylinder and out at the metal mouth into a rubber tube passed down the mouth of the bird to be crammed.

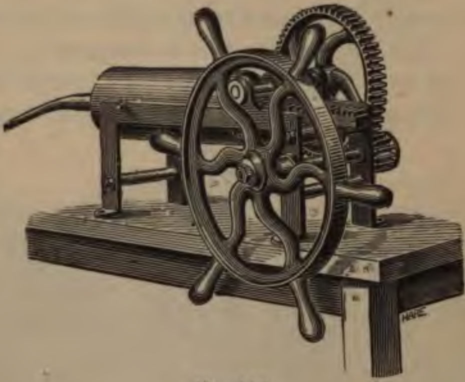


Fig. 116.

CHAPTER XX.

MISCELLANEOUS IMPLEMENTS AND MACHINES.

Steam Sawing Machinery. — Since the introduction of light portable engines, the demand for this class of machinery has largely increased.

The portable steam saw-bench illustrated in Fig. 117 has been specially designed by R. Garrett and Sons to suit the requirements of landed proprietors and others for country use. It is fitted with Lakeman's saw-guard, which insures safety for the attendant; and with adjustable fence for cutting parallel or bevelled work of every description to the greatest nicety. The respective advantages of a fixed and portable saw-bench are thus combined, and a most invaluable and inexpensive saw-bench for general purposes is produced.

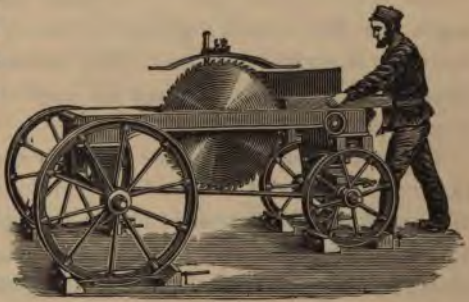


Fig. 117.

Fig. 118 shows a set of Marshall and Sons' steam sawing machinery in position cutting up timber at the place of its growth.

This plan of converting timber is found to be highly advantageous both in this country and abroad, as each part is self-contained and portable, and is very readily fixed down. The sawing machines are driven direct from the engine through belts from two separate fly-wheels, and the engine being constructed to burn wood, chips, and sawdust, fuel is supplied free of cost. The saws are flat circular pieces of steel, having teeth cut upon their outer edge. They are made of various sizes, and shaped for ripping up large stuff or for cutting small wood.

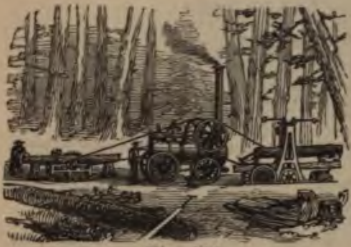


Fig. 118.

The saw has a hole in the centre exactly the size of the turned end of the spindle upon which it is placed, and another disc of iron is screwed upon it, pressing it and holding it securely against the other, and in its place, so as to run perfectly true. The movable portion of the bed-plate is then replaced, and rather less than half the saw appears above the surface of the table. A strap from the engine or from some part of the machinery in motion is placed upon the loose pulley on the spindle when the saw is required to be used; the strap is pressed towards the fixed pulley, which, from its shape, immediately runs upon and gives motion to the saw. It is necessary that the saw should revolve at a high speed, or it will not be effective.

Bone and Coprolite Mills.—The grinding of bones for manure is one of those operations that can only be well effected where the steading is equipped with a steam-engine. Steamed or boiled bones are, however, much easier to crush than raw bones, and steaming the bones in no wise impairs their efficacy when applied to the land. On the contrary, steaming or boiling renders the bones more readily assimilable as plant food; and, as a quick return is most wanted by the farmer, there is no doubt that super-heated bones, ground into dust, and drilled in with the seed, is the best possible method of using this valuable and highly fertilising manure.

Bone-crushing still continues to be done almost quite as a separate business, and the mills are large and expensive; but there is no reason why a small bone-mill should not be attached to every steading. In the few cases where this is so, they are found highly advantageous; for a greater or less quantity of bones can be collected on every farm or picked up in the neighbourhood; and when the farmer has to purchase the bones he can tell what he is paying for, which is not always the case when he buys prepared bone-dust.

Bone-grinding is effected by passing the bones through a series of toothed rollers arranged in pairs, the rollers being toothed or serrated in different degrees of fineness, and riddles are provided for sifting the bones into sizes, and they are then sold as quarter-inch bones and bone-dust.

One of Hall's small bone-mills, for farm use, is capable of breaking 3 tons of bones per day with a 3 horse-power engine, and separate the same into three sizes, viz: dust, $\frac{3}{8}$, and $\frac{3}{4}$ in. cubes.

The distinctive features of this mill are (1st) an improved method of driving the rolls by a combination of differential gear and friction, sheave and strap, with a better balance of the high-speed shaft than heretofore. This enables the rolls to be driven at a greatly reduced speed over the first motion shaft, thus increasing the power available for crushing the bones; yet it is capable of adjustment by hand, so that whilst crushing the hardest bone, it will slip in the event of a harder substance such as a horseshoe or piece of iron getting between the rolls. (2nd) The rolls are made to open and close for coarser or finer crushing, and when dealing with large bones they may be expanded by turning a couple of screws to rough the bones down for further treatment if necessary. (3rd) A revolving screen made of perforated steel plate is supplied with the machine when required with necessary driving gear. (4th) The frame of the mill being in one box casting, it is very rigid; stands firmly to its work, and improves the general appearance of the mill. It is self-contained, and requires no special foundation to be provided. These mills can be used for a variety of purposes in addition to crushing bones, as, for instance, in cracking nuts of all kinds where the shell is only to be destroyed and the kernel preserved. This is important where oil, &c., is extracted therefrom.

Price of mill complete, with screening apparatus, £60.

Fig. 119 is a section of Hall's "Victor" Bone-Mill, in which will be seen the latest improvements for the reduction of bones, necessitated by the demand for a finer quality of crushed bones

The upper rollers are composed of coarse serrated iron rings. One roll is adjustable to and from its *fellow for* coarsing or finer crushing, whilst a third or pulverizing roll is added underneath, composed of rings of fine serrated teeth, and running at a high speed, and in conjunction with the upper adjustable roll, so that any reasonable degree of fineness or pulverization may be obtained at one operation, and yet the machine may be used only for rough crushing by simply opening the top roll.

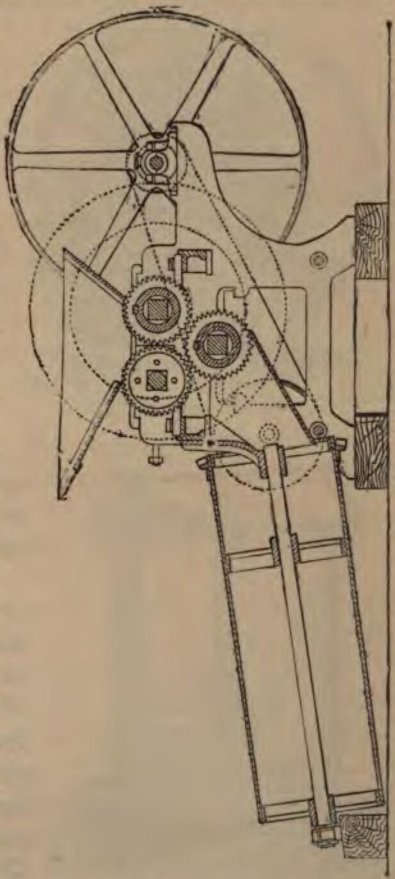


Fig. 119.

The essential feature of this mill, it is seen, is the addition of a third or pulverizing roller, with fine teeth, and running at a much higher speed than the two upper crushing-rollers, thus clearing the teeth and reducing still finer the crushed bones as they fall from the upper pair.

This mill is made in five different sizes, capable of crushing from 2 to 10 tons of bones per day. The price of the smaller size is £30.

These mills are equally suitable for grinding coprolite.

Apple-Mills.—The manufacture of cider in the apple-growing districts, Herefordshire, Devonshire, &c., is an operation of great importance, and conducted with all the care and attention that is bestowed upon any other process for converting the produce of the land into a marketable commodity. Cider is made from the juice of the apple.

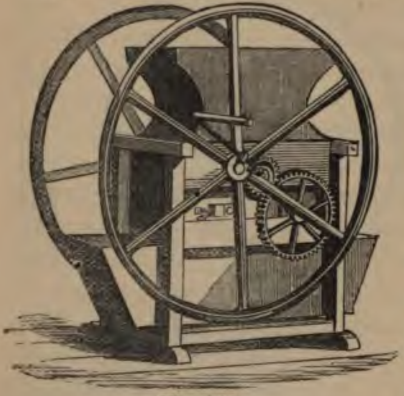


Fig. 120.

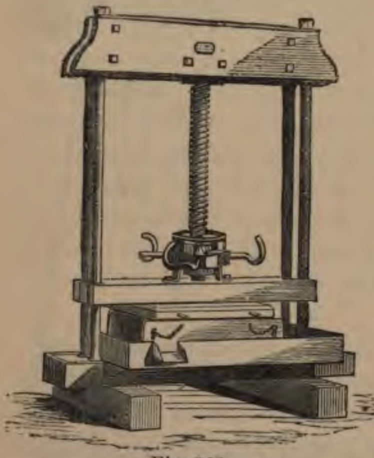


Fig. 121.

The old form of apple-mill has a wooden cylinder, upon the surface of which nails are fixed, the sharp heads of which project above the cylinder about one-eight of an inch. The apples are filled into a hopper placed over the cylinder, and led into a narrow cavity at the upper side of it. The *cylinder is turned* by hand, horse, or other power, and the apples are reduced to a fine pomace, grated, not pressed.

An improved Apple-mill, by the Bristol Waggon Works Company, is represented in Fig. 120. It is fitted with two pairs of rollers, the top rollers of wood, with thirty teeth in each, working opposite each other, thus taking a firm grip of the apple, which is crushed while passing through to the under rollers. These are of Pennant stone, accurately turned, so as to reduce the fruit to a pulp, and to crush the pip; this is very desirable, as it improves the quality and flavour of the cider. The feed can be easily regulated by means of a slide in the hopper according to the power. Two men will grind easily about ten sacks of apples per hour.

Cider-Presses.—An improved small screw Cider-press, by the same makers, is shown in Fig. 121. It is fitted with 2½ in. best wrought-iron screw and nut, and has a strong timber frame secured by wrought-iron plates.

Double-screw presses, on the same principle, are also to be obtained.

Harness-Brackets.—For heavy cart-horse harness the brackets require to be extra strong. Some excellent cast-metal fittings of this kind are supplied by the St. Pancras Iron Works. A breeching, bridle, collar, and double-rein bracket is allotted to each horse. The arrangement shown in Fig. 122 may be varied in the relative positions of the brackets. When the pad requires to be supported instead of hung, a different kind of bracket to the breeching one shown in the figure is used.

Implement-Racks.—No stable should be without these useful appendages for holding forks, shovels, brooms, &c. The racks illustrated in Fig. 123 answer the purpose admirably. By having a hanging-place for the stable implements they can be got when

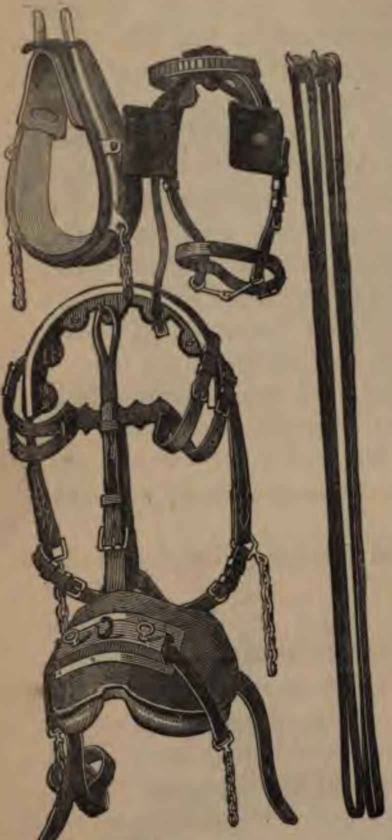


Fig. 122.

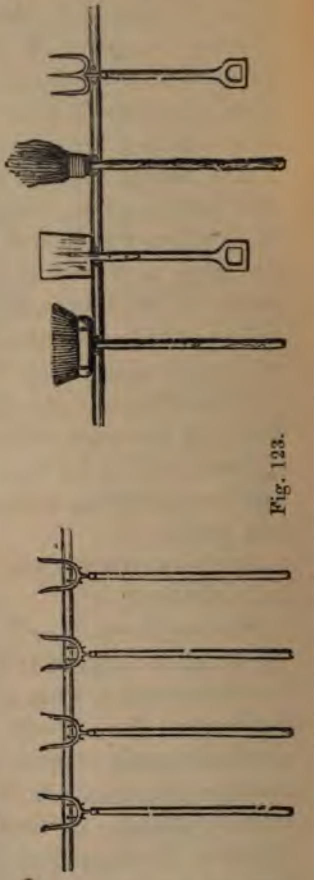


Fig. 123.

wanted; there is no fear then of their getting amongst the horses' feet; and the stable has a more tidy appearance.

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